Combining Genetics and Morphology to Resolve a Longstanding Taxonomic Issue: how many Bottlenose Dolphin Species are there in Australian Waters?

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To my family

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Abstract

Relationships in the family Delphinidae in general and the genus *Tursiops* in particular are controversial. Within this complex, the *Delphinus-Stenella-Tursiops* clade has proven to be the most problematic, as previous studies suggested that *Tursiops aduncus* (Indo-Pacific Bottlenose Dolphin) is more closely related to *Stenella* and *Delphinus*, rather than to its congener *Tursiops truncatus* (Common Bottlenose Dolphin). In Australian waters, geographically restricted morphological and genetic analyses confirmed the presence of two species, aligned with *T. aduncus* and *T. truncatus*. A putative third species, *Tursiops australis* (Burrunan Dolphin), has been named in parts of south-eastern Australia, but has not been officially recognised by the Committee on Taxonomy. By assembling the largest dataset of its kind and using a combination of morphological and genetic markers, my thesis addresses some of these taxonomic uncertainties in Australian waters, focusing on the genus *Tursiops*.

First, I examined 347 skulls of *Tursiops*, *Stenella*, *Delphinus*, *Steno*, *Lagenodelphis* and *Sousa* in order to resolve the position of Australian *Tursiops* relative to these taxa, including five *Tursiops* type specimens. I described cranial morphology using 2-dimensional (2D) and 3-dimensional geometric morphometrics (3DGM), counts and categorical data. My results showed a clear separation between *Tursiops* and other genera, including type specimens, as *Tursiops* formed a distinct monophyletic group with no overlap with other taxa. The three *Stenella* species did not cluster together. Rather, *S. coeruleoalba* clustered with *L. hosei*, *S. attenuata* with *D. delphis*, and *S. longirostris* formed a distinct group with no overlap to other taxa. My results challenge previous genetic studies that identified *Tursiops* as polyphyletic. The congruence of the 2D and 3DGM methods confirmed that *Tursiops* spp. forms a monophyletic group, but species within *Tursiops* did not show a clear separation from each other based on these analyses.

In a second step, I examined 264 *Tursiops* spp. skulls and 90 skeletons, including the type specimens, in order to address the number of potential *Tursiops* species in Australian waters. My results supported the existence of *T. aduncus* and *T. truncatus*, aligned with their type specimens. However, there was no morphological differentiation between *T. australis* and *T. truncatus*. Both 2D and 3DGM showed the importance of size when separating groups or subgroups. Generally, nearshore *T. aduncus* appeared to be smaller compared to the pelagic *T. truncatus*, and also exhibit a positive relationship between size and latitude. My 3DGM analyses showed some geographical trends between subgroups, where for example, *T. australis* clustered in one subgroup together with *T. truncatus* from southern Australia, while the second *T. truncatus* subgroup contained specimens from the same area but also from northern parts. Both 2D and 3DGM showed the importance of environmental influences on morphology.

To investigate genetic relationships within *Tursiops* in Australian waters, both on species and population levels, I employed autosomal and sex-specific markers (mitochondrial DNA and Y-chromosomal markers). I used 648 soft tissue samples, of which 498 had known provenance, as well as 210 bone and tooth samples from carcasses collected from coastal and

offshore locations around Australia. All genetic markers supported two major clusters, aligning with *T. aduncus* and *T. truncatus*. However, in southern parts of Australia I identified three lower-level genetic clusters, one of them aligning with *T. australis*, which appeared to occur at least partly in sympatry. Each of the three clusters showed mixed characters with respect to the three genetic marker systems employed. *Tursiops australis* could not be systematically distinguished from *T. aduncus* or *T. truncatus* across all three marker systems (autosomal, mtDNA and Y-chromosomal markers), suggesting that further work is required. In summary, given a combination of genetic and morphological data, there appears to be insufficient support for *T. australis* on the same taxonomic level as *T. aduncus* and *T. truncatus*. Future work should be aimed at using genome data to reconstruct the demographic history of the three clusters found in southern Australia in an attempt to evaluate their evolutionary independence. Such an analysis might aid in determining the status for *T. australis.*

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Chapter 1

General Introduction

1.1. Taxonomy, applications and aims

Taxonomy is the science of naming and classifying organisms (Cronin 1993, Guerra-García *et al*. 2008), which dates back to when Linnaeus introduced the classification system that is still used today (Godfray 2002). A complex set of rules was invented to, for example, determine how species should be named and associated with a type specimen (Godfray 2002). Modern taxonomy can be divided into two systems, morphological and genetic taxonomy, where one might be favoured over the other (Godfray 2002, Dayrat 2005). However, they are complementary systems with the same goal that can be used concurrently, which might be a necessary approach for some taxa that are difficult to delineate (Dayrat 2005).

There are numerous Species Concepts available that will vary depending on what concept is adopted by the taxonomist (Helbig *et al.* 2002). Examples of species concepts are;

- the Evolutionary Species Concept (Simpson 1961, Wiley 1978) that is defined as: 'An entity composed of organisms that maintains its identity from other such lineages and has its own independent evolutionary tendencies and historical fate' (reviewed and modified in Fraser and Bernatchez 2001).
- the Phylogenetic Species Concept (Cracraft 1983) that is defined as: 'The smallest diagnosable cluster of individual organisms with which there is a parental pattern of ancestry and descent'
- the Biological Species Concept (Mayr and Ashlock 1991) that is defined as: 'A species is a group of interbreeding natural populations that is reproductively isolated from other such groups'

Regardless of what concept is adopted, a species is recognisable if it retains its phenotypical and genetic differences even when in contact with other populations or taxa (Helbig *et al.* 2002).

Morphological and/or genetic methods have been used to define species (Mallet 1995, Chiari *et al.* 2009, Xiong *et al.* 2009, McGowen 2011, Perrin *et al*. 2013), although each has its limitations for several reasons. For instance, speciation is not always accompanied by morphological changes so the true number of species could be greater than those described (Bickford *et al*. 2007). For example, geographical variation can result in several morphological ecotypes within the same species (Perrin 1984). In contrast, cryptic and sibling species can be difficult to recognise as putative taxa rather than extreme morphological variants of more common widespread taxa (Case *et al*. 1998). In cases when morphological separation is difficult, a molecular approach may help to identify the number of species and in reconstructing the relationships among them (Bickford *et al*. 2007), although it is not advisable to name new species solely based on genetic data (Kipling *et al*. 2005). For instance, disentangling relationships between species with short and rapid evolutionary histories, can lead to difficulties in resolving short branches produced by cladistics analyses

(LeDuc *et al.* 1999, Buchholtz and Schur 2004, Kurihara and Oda 2007, Xiong *et al.* 2009, McGowen 2011, Perrin *et al*. 2013), and may reveal evolutionary processes other than phylogenetic descent (Leaché and McGuire 2006, McGuire *et al.* 2007, Mila *et al.* 2011), such as incomplete linage sorting (Nikaido *et al*., 2007, Perrin *et al*. 2013).

It is important to note, however, that morphological and genetic methods should not be seen as competing, but rather complementary (Dayrat 2005). No species definition has proven to be completely objective (Helbig *et al.* 2002) and an integrative taxonomic approach is therefore recommended (Ballard and Whitlock 2004, Kipling *et al*. 2005). However, the development and integration of multiple methods can sometime complicate the interpretation due to contradicting outcomes (Mallet 1995, Helbig *et al.* 2002, Kurihara and Oda 2007).

1.2. The Australian marine environment

The Australian mainland is surrounded by a relatively narrow continental shelf, with the exception of the tropics and the Great Australian Bight (Australian State of the Environment Committee 2001). The continental shelf ranges from less than 15 km in width off the coast of New South Wales in the southeast, to greater than 400 km between the coasts of New Guinea and Australia in the region of the Arafura Sea and Torres Strait, thus creating shallow waters (Bunt 1987, Australian State of the Environment Committee 2001).

Environmental conditions have varied considerably in the past creating new marine environments by forming or removing barriers to migration and radiation of organisms. The northern parts of the continent moved from a temperate to a tropical climate, while the southern parts moved from polar to temperate.

During the Pleistocene, climate fluctuations occurred with glacial- and interglacial cycles (Frakes *et al*. 1987, Hofreiter and Stewart 2009). These caused major fluctuations in sea levels (Frakes *et al*. 1987), changing coastal topography, causing patterns of isolation between areas of available habitat (Gaither and Rocha, 2013, Stewart *et al*. 2010), influencing the spatial and temporal distribution of marine taxa (Hofreiter and Stewart 2009, Stewart *et al*. 2010), and increasing diversification rates (Steeman *et al*. 2009). The last glacial-interglacial cycle lasted from about 120 kya to 10 kya, with conditions similar to those of today (Frakes *et al*. 1987). During warm interglacial periods, sea levels were high, flooding the continental shelf in the Gulf of Carpentaria and separating Tasmania and mainland Australia (Frakes *et al*. 1987).

Australia is surrounded by several major ocean currents, each having a significant influence on the climate and biological productivity of ecosystems and biodiversity of the coastal region (Australian State of the Environment Committee 2001, Commonwealth of Australia 2007, Commonwealth of Australia 2009). Australia is unique in having two south-flowing warm currents; the East Australian Current and the Leeuwin Currents in the west. The East Australian Current transports warm, nutrient-depleted, high-salinity water from the tropics south along the east coast to the southern part of Tasmania (Australian State of the Environment Committee 2001, Commonwealth of Australia 2009). The Leeuwin Current is

formed near the North West Shelf on the west coast of Australia and transports warm, nutrient-depleted water from the tropics southward and extends across the Great Australian Bight to about Bass Strait, depending on the year (Australian State of the Environment Committee 2001, Commonwealth of Australia 2007).

1.2.1. Delphinid evolution, diversity and taxonomic uncertainties

More than 50 million years ago, cetaceans made the transition from terrestrial specialists to semiaquatic and then aquatic specialists (Hoelzel 2009, Fordyce 2009). Cetaceans, *i.e.* whales, dolphins and porpoises, evolved from Ungulata, a group that includes all modern orders of hooved animals (Hoelzel 2009). The evolutionary lineage leading from the ancestral odontocetes (or 'toothed whales') to the Delphinidae is moderately well understood based on the fossil record (Barnes 1990, LeDuc *et al*. 1999, Fordyce 2009). The origins of Delphinidae date from about 10 Mya in the late Miocene/early Pliocene (Barnes 1990, McGowen *et al.* 2009, Steeman *et al.* 2009, Zhou *et al.* 2011), and this was followed by rapid speciation (McGowen *et al*. 2009, Steeman *et al*. 2009).

The forces behind this rapid, adaptive radiation are still unclear, with possible drivers including echolocation, brain size and behaviour (Barnes 1990, McGowen *et al.* 2009, 2011, Steeman *et al.* 2009). Barriers to connectivity of the marine environment, increased primary ocean productivity, intensified ocean circulation, food specialisation, and changing global sea levels are also believed to be significant contributing factors (Steeman *et al*. 2009). These specialisations have led to the Delphinidae being the most speciose, and morphologically and taxonomically diverse cetacean family (Barnes 1990, Berta and Sumich 1999, Fordyce 2009). Species vary greatly in size, external appearance, dentition, social behaviour, habitat preference and food habits (Reeves *et al.* 2002). Some species are migrants while others are resident (Evans and Raga 2001). The six subfamilies include 17 genera and 38 species (Committee on Taxonomy 2018) in the subfamilies: Cephalorhynchinae, Stenoninae, Lissodelphinae, Orcaellinae, Globicephalinae, and Delphininae (Rice 1998, LeDuc 2009). Species within Delphinidae occur in a wide range of habitats, including pelagic, shallow coastal, and tropical and temperate waters (Reeves *et al.* 2002).

Delphininae contains five genera: *Stenella*, *Lagenodelphis*, *Sousa*, *Delphinus*, and *Tursiops*, and 12 recognised species (LeDuc 2009, Perrin *et al*. 2013), although the taxonomic distinction and phylogenetic relationships among some of the genera and species within this subfamily have proven difficult to distinguish using both morphological and genetic methods (LeDuc *et al*. 1999, McGowen 2011, Amaral *et al*. 2012, Perrin *et al*. 2013). The *Delphinus-Stenella-Tursiops* clade appears to be the most problematic, where genetic studies to date have been unable to resolve the evolutionary history despite increased number of markers and development of more sophisticated data analyses (Perrin *et al*. 2013). Morphological analyses show clear separation between *Tursiops* and some other delphinid genera (Amaral et al. 2009, Perrin 1975, Wells and Scott 1999, Perrin 2001, Shirakihara *et al*. 2003). The difficulty separating *Delphinus-Stenella-Tursiops* might be due to difficulties in identifying clear diagnostic morphological characters (Buchholtz and Schur 2004, Amaral 2009), resolving

short branches in cladistic analyses (McGowen 2011), incomplete linage sorting (Nikaido *et al*. 2007, Perrin *et al*. 2013) or a combination thereof.

1.2.2. The evolution of the genus *Tursiops* and taxonomic considerations

The fossil record shows that the earliest *Tursiops* appeared about 5 Mya, although fossils are not commonly recoded prior to 1.75 Mya (Barnes 1990). Resolving the taxonomy of *Tursiops* has been attempted in many studies in parts of the world (Ross 1977, 1984 for South Africa, Wang *et al*. 1999, 2000*a, b*, Natoli *et al*. 2004 for China, Hale *et al*. 2000, Möller and Beheregaray 2001 and Kemper 2004 for Australia). Variation in size, coloration and skull characters has led to the naming at least 20 nominal species (Rice 1998). However, currently two species are recognised world-wide, *T. truncatus*, and *T. aduncus* (Committee on Taxonomy 2018). A third species, *Tursiops australis* (Burrunan dolphin), was named as a distinctive nominal species of *Tursiops* from Australia (Charlton-Robb *et al.* 2011), but has not yet been accepted at a worldwide level (Committee on Taxonomy 2018).

Globally, *T. aduncus* and *T. truncatus* have been distinguished using both morphological and genetic methods (Hersh and Duffield 1990, Mead and Potter 1995, Rice 1998, LeDuc *et al.* 1999, Perrin *et al.* 2013). *Tursiops aduncus* is usually smaller in body and skull size (Ross, 1977, Wang *et al.* 2000*a*, Kemper 2004), with fewer vertebrae and generally more teeth that are smaller in diameter (Wang and Yang 2009, Natoli *et al*. 2004, Hale *et al.* 2000, Ross 1977). However, some of these measurements and characters show overlap, confounding species separation (Ross, 1977, Wang *et al*., 2000*b*, Kemper, 2004). Some mtDNA studies support polyphyly for *Tursiops* (LeDuc *et al*. 1999, Kingston *et al.* 2009, Moura *et al*. 2013), while others including nuclear DNA, support monophyly (McGowen *et al.* 2009, Steeman *et al.* 2009). A revision of the genus has been recommended (Hersh and Duffield 1990, Mead and Potter 1995, Rice 1998, LeDuc *et al.* 1999, Perrin *et al.* 2013).

In some parts of Australia, studies have found support for *T. aduncus* and *T. truncatus* morphologically (Hale *et al.* 2000, Kemper 2004) and genetically (Möller and Beheregaray 2001, Allen *et al*. 2016). Currently, an Australia-wide morphological and genetic study is lacking. *Tursiops australis* is intermediate in size between *T. aduncus* and *T. truncatus* but based on mtDNA different from other *Tursiops* species (Charlton-Robb *et al.* 2011). That study used small sample sizes from a restricted geographical range within Australian waters and there was no comparison with type specimens of *T. aduncus* and *T. truncatus.* In addition, there was low support for molecular differences and overlap in metric characters (Committee on Taxonomy 2018). Factors that might contribute to the taxonomic confusion within *Tursiops* include lack of broader regional perspective (Kemper 2004), sympatry of the two species in some regions (Hale *et al.* 2000, Wang *et al.* 2000*a, b*), wide distribution leading to morphological and genetic variation due to geographical adaptation (Wells and Scott 2009), and differences in research methods and designs (Perrin 2009). Some of the aforementioned issues will be addressed in my study. The increased sample size and geographical coverage compared to previous studies will shed light on the distribution of species around the coast of Australia, including *T. australis*.

1.3. Methodological aspects

1.3.1. Morphology

Taxonomic studies often use linear two-dimensional (2D) morphological data (Adams *et al.* 2004, Chiari *et al.* 2009), in combination with multivariate statistical methods. These data can include external morphology, linear skull measurements, postcranial skeletal and tooth counts, and categorical variables. In my thesis, I included linear skull measurements (Perrin 1975, Ross 1977, Wang *et al.* 2000*b*, and Kemper 2004), categorical variables, tooth counts and diameter (Kemper 2004).

More recently, three-dimensional geometric morphometric methods (3DGM; Rohlf and Marcus 1993), in combination with multivariate statistics (Rohlf 2003) have been employed when studying cetaceans. These techniques capture shape through a set of landmarks for each specimen (Marcus *et al.* 2000) and are complementary to 2D data because they can eliminate size effects, leaving the variation of shape to be compared (Rohlf 2003). Geometric morphometrics have proven useful in solving a variety of taxonomic problems (Astua 2009, Pierce *et al.* 2009, van der Niet *et al.* 2010), in particular when studying closely-related species (Dobigny *et al.* 2002, Cardini and O'Higgins 2004, Pizzo *et al*. 2006) such as cetaceans (Gutstein *et al.* 2009, Hampe and Baszio 2010, Nicolosi and Loy 2010).

Three-dimensional geometric morphometrics methods were successfully employed in studies separating offshore and inshore species in *Sotalia* (de Araujo Monteiro-Filho *et al.* 2002), as well as separating *T. truncatus*, *D. delphis* and *S. coeruleoalba* based on rostral and cranial shape (Amaral *et al.* 2009). Shape differences between inshore and offshore *Sotalia* suggest that the cranium of the offshore specimens was in line with the vertebral column compared to pointing downwards in inshore specimens (de Araujo Monteiro-Filho *et al.* 2002). These differences may be related to feeding specialisation and echolocation (de Araujo Monteiro-Filho *et al.* 2002, Amaral *et al.* 2009), which have also been found in other species. *Tursiops truncatus* had a larger braincase and shorter rostrum compared to *D. delphis* and *S. coeruleoalba*, *D. delphis* has a narrower braincase with relatively long rostrum when compared to the cranial portion of the skull, while *S. coeruleoalba* had a relatively large braincase and short rostrum (Amaral *et al.* 2009).

1.3.2. Genetic marker systems

Genetic markers differ in genome size, mode of inheritance, number of introns, ploidy, recombination and mutation rate, and effective population size (Lin and Danforth 2004). Thus, the appropriate marker system relates to the scientific question being asked. Because single markers usually provide a limited perspective (such as strictly matrilineal inheritance of mtDNA; Avise *et al*. 1987), a combination of marker systems with different inheritance modes will allow a more complete picture of evolutionary and demographic processes shaping the current genetic makeup of populations (Lin and Danforth 2004). This is why I used autosomal as well as two sex-linked marker systems in my thesis.

Nuclear markers and are biparentally inherited. One class of nuclear markers are so-called 'microsatellites' (or short-tandem repeats, STRs), which are short, tandemly repeated sequences with repeat units between 2-6 base pairs in length (Ellegren 2004, Selkoe and Toonen 2006). Most microsatellites are found in non-coding DNA and are thus assumed to evolve neutrally (Ellegren 2004). Polymorphic microsatellite markers differ in the total number of repeat units that are highly variable among individuals (Ellegren 2004, Lin and Danforth 2004, Selkoe and Toonen 2006). They have a high mutation rate, which makes them suitable for studies of relatively recent evolutionary processes (Ellegren 2004, Lin and Danforth 2004, Selkoe and Toonen 2006). Microsatellites have been used to describe population structure and admixture and are relatively easy to work with, but they require a species-specific marker isolation (Lin and Danforth 2004, Selkoe and Toonen 2006).

Mitochondrial DNA markers are inherited from females. One of the commonly used mtDNA sequences is on the hypervariable region 1 (HVR1), found within the control displacement loop (D-loop) region. This region is non-coding and thus accumulates mutations faster than the remainder of the mtDNA genome (Avise *et al*. 1987, Ballard and Whitlock 2004, Lin and Danforth 2004), which makes it suitable for phylogenetic analysis, using the female perspective of closely related taxa. Because of clonal inheritance and the absence of recombination, coalescence analyse using this marker system is statistically and computationally more straightforward (Lin and Danforth 2004). Relative to nuclear DNA, mtDNA sequences occur in larger quantities (Avise *et al*. 1987) and are thus, much easier to amplify (Ballard and Whitlock 2004, Lin and Danforth 2004) and to work with.

Analogous to mtDNA, Y-chromosomal markers from the non-recombining part of the Y-chromosome are inherited from males. In my thesis, I used conserved singl-nucleotide polymorphisms located within introns of Y-chromosomal genes, so called Y-chromosomal conserved anchor tagged sequences (Y-CATS, Hellborg and Ellegren 2003). Species-specific markers on the Y-chromosome are not commonly used because of the difficulty discovering polymorphic Y-chromosome-specific markers in natural populations and in generating sequence data, which is mainly due to the highly complex architecture of the Y-chromosome (Murphy *et al.* 2006, Mattle-Greminger 2016). In addition, the Y-chromosome is usually very small and gene content can vary significantly between species (Waters *et al.* 2007). Since males and females usually do not contribute equally to the next generation (Greenwood 1980), an additional reason for including Y-chromosomal markers is to complement the results from the maternally-inherited mtDNA.

1.4. Study aims and structure of the thesis

The aim of this thesis is to investigate the taxonomy and distribution of bottlenose dolphins in Australia, using the largest data set analysed to date. Where possible, I generated morphological and genetic data from the same individual, including some type specimens. A MSc thesis project by Sandra Gross, at the Anthropological Institute and Museum of the University of Zurich, was created as a subproject to add a third genetic marker. My thesis is structured into a general introduction, three data chapters and a general discussion. The data

chapters have either been published as papers in peer review journals, or are in preparation for submission. Brief outlines for the data chapters are provided below.

Chapter 2: Cranial morphology and taxonomic resolution of some dolphin taxa (Delphinidae) in Australian waters, with a focus on the genus Tursiops

This chapter was published in Marine Mammal Science (Jedensjö *et al*. 2017). We used skull morphology (linear two-dimensional and three-dimensional geometric morphometric data) to investigate phylogenetic relationships within some Australian Delphinidae (*Tursiops, Delphinus, Stenella, Steno, Lagenodelphis,* and *Sousa*), with a focus on the genus *Tursiops*.

Chapter 3: Taxonomy and distribution of bottlenose dolphins in Australia: an osteological clarification

This chapter is currently under review in the Canadian Journal of Zoology (Jedensjö *et al*. submitted). We investigated the taxonomy and distribution of bottlenose dolphins in Australia. We used linear two-dimensional data, which allowed comparison with previous studies, and three-dimensional geometric morphometric data to provide more detailed analysis of the relative contribution of allometric and non-allometric factors.

Chapter 4: Genetic structure of the genus Tursiops in Australian waters: Simple in the north and complex in the south

This chapter will be submitted to Marine Mammal Science (Jedensjö *et al*. in prep.). We investigated how many bottlenose dolphin species that occur in Australian waters by comparing results from three genetic marker systems (mitochondrial DNA, autosomal microsatellites, and Y-chromosomes) on an individual level, and compare to previous morphological results for some individuals.

Chapter 2

Cranial morphology and taxonomic resolution of some dolphin taxa (Delphinidae) in Australian waters, with a focus on the genus *Tursiops*

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Key words: *Tursiops*, *Stenella*, *Delphinus*, *Lagenodelphis*, *Sousa*, *Steno*, Delphininae, Delphinidae, morphology, geometric morphometrics.

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Author contributions:
Maria Jedensjö conceived the study, conducted data collection from the museums, conducted statistical analyses, and wrote the manuscript.
Catherine M. Kemper and Michael Krützen conceived the study and edited the manuscript.

2.1. Abstract

Phylogenetic relationships in the family Delphinidae have been widely debated. We examined 347 skulls of *Tursiops*, *Stenella*, *Delphinus*, *Steno*, *Lagenodelphis*, and *Sousa* in order to resolve the phylogenetic position of Australian species of *Tursiops*. Five *Tursiops* type specimens were included. Cranial morphology was described using 2-dimensional (2D) and 3-dimensional geometric morphometrics (3DGM), counts and categorical data. Analyses showed a clear morphological separation of *Tursiops*, including type specimens, from other genera. The three *Stenella* species did not cluster together. *Stenella attenuata* clustered with *Delphinus delphis*, and *Stenella coeruleoalba* with *Lagenodelphis hosei*. Length and width of the skull and rostrum were important discriminators in both methods. For 3D data, round *vs*. angular posterior skull shape distinguished some genera. Taxa that overlapped in the multivariate analyses had different mean tooth counts. Our study challenges genetic studies that identified *Tursiops* as polyphyletic, with *T. aduncus* closer to *S. attenuata*.

2.2. Introduction

The family Delphinidae is the most morphologically and taxonomically diverse living cetacean family (Barnes 1990, Berta and Sumich 1999, Fordyce 2009) containing six subfamilies; Cephalorhynchinae, Stenoninae, Lissodelphinae, Orcaellinae, Globicephalinae, and Delphininae (Rice 1998), 17 genera and 38 species (Committee on Taxonomy 2015). Its evolutionary history is relatively well understood (Barnes 1990, LeDuc *et al.* 1999, Fordyce 2009), pointing to an origin in the Miocene about 11−12 Mya (Barnes 1990, McGowen *et al.* 2009, Steeman *et al.* 2009) followed by rapid speciation (McGowen *et al.* 2009, Steeman *et al.* 2009). However, it has proven difficult to identify the driving forces behind this adaptive radiation (Norris 2000). Possible drivers include different social systems, as well as brain size and echolocation, probably in combination with large-scale ocean restructuring during the late Miocene and early Pliocene (Steeman *et al.* 2009).

The subfamily Delphininae contains five genera: *Stenella*, *Lagenodelphis*, *Sousa*, *Delphinus*, and *Tursiops*, and 12 recognised species (Perrin *et al.* 2013). The taxonomic distinction and phylogenetic relationships of some have proven difficult (LeDuc *et al.* 1999, McGowen 2011, Perrin *et al.* 2013). A review of morphological and genetic studies was published by Perrin *et al.* (2013), and suggested that neither morphology nor genetics has fully resolved the problem. This may be due to rapid radiation of the group (McGowen 2011, Perrin *et al.* 2013), the difficulty in resolving short branches produced by cladistic analyses (McGowen 2011), and the difficulty identifying clear diagnostic morphological characters (Buchholtz and Schur 2004, Amaral 2009), as well as incomplete linage sorting (Nikaido *et al.* 2007, Perrin *et al.* 2013). A comprehensive morphological study including all delphinids has previously not been conducted (Perrin *et al.* 2013), but cladistic analyses of some taxa are available (Perrin *et al.* 1987, de Muizon 1988, Geisler *et al.* 2011, Murakami *et al.* 2014).

The most problematic clade within Delphininae is that containing *Delphinus*-*Stenella*-*Tursiops* (LeDuc *et al.* 1999, Perrin *et al.* 2013). Previous morphological work showed that *Tursiops* can be distinguished from *Delphinus* and *Stenella* by having fewer teeth and vertebrae (Perrin 1975, Wells and Scott 1999, Perrin 2001, Shirakihara *et al.* 2003). The distinction between *Delphinus* and *Stenella* is more difficult, due to overlapping variables. Species within these two genera can be separated by variation in the extent of development of palatal grooves in *Delphinus* (Perrin 1998) and possession of a sigmoid ramus in *Stenella* (Archer and Perrin 1999).

Taxonomic studies have often used two-dimensional (2D) morphological variables to name and classify organisms (Cronin 1993, Adams *et al.* 2004, Chiari *et al.* 2009). Recently, three-dimensional geometric morphometrics (3DGM), in combination with multivariate statistical methods, has been used because they eliminate the effects of size, leaving variation of shape to be compared (Rohlf 2003). These methods have been used on many groups of organisms (Astua 2009, Pierce *et al.* 2009, van der Niet *et al.* 2010) and have proven useful when studying closely related species (Dobigny *et al.* 2002, Pizzo *et al.* 2006), including cetaceans (Gutstein *et al.* 2009, Hampe and Baszio 2010, Nicolosi and Loy 2010). For example, separation of inshore and offshore species of *Sotalia* (de Araujo Monteiro-Filho *et al.* 2002),

and three species within the *Delphinus-Stenella-Tursiops* clade (Amaral *et al.* 2009) has been successful. Amaral *et al.* (2009) were able to separate *Tursiops truncatus*, *Stenella coeruleoalba*, and *Delphinus delphis* based on rostral and cranial shape.

Some genetic studies support monophyly for *Tursiops* (McGowen *et al.* 2009, Steeman *et al.* 2009), while others support polyphyly (LeDuc *et al.* 1999, Kingston *et al.* 2009, Xiong *et al.* 2009). Mitochondrial DNA studies have concluded that *Tursiops aduncus* (Indo-Pacific bottlenose dolphin) is more closely related to *Stenella* and *Delphinus* than to *T. truncatus* (LeDuc *et al.* 1999, Möller *et al.* 2008, Charlton-Robb *et al.* 2011). There is no clear morphological or molecular resolution of phylogenetic relationships, especially not within Delphininae (Perrin *et al.* 2013, Committee on Taxonomy 2015). Genetic, morphological, and physiological studies suggest that a taxonomic revision of the genus *Tursiops* is needed (Hersh and Duffield 1990, Mead and Potter 1995, Rice 1998, LeDuc *et al.* 1999, Perrin *et al.* 2013).

Currently there are two recognised species of *Tursiops* world-wide, *T. truncatus* and *T. aduncus* (Committee on Taxonomy 2015), and both occur in Australian waters (Ross and Cockcroft 1990, Möller and Beheregaray 2001). A third species, *Tursiops australis*, has been described (Charlton-Robb *et al.* 2011) but has not been widely accepted yet (Committee on Taxonomy 2015).

The present study used skull morphology to investigate phylogenetic relationships, for the first time, within Australian Delphinidae (*Tursiops, Stenella, Delphinus, Steno, Lagenodelphis*, and *Sousa*), with focus on the genus *Tursiops*. Two morphological methods were used (2D and 3DGM), for comparison and utilised skull length, width, and shape data.

2.3. Material and Methods

Specimens

Data were obtained from 347 skulls that were cranially mature according to Ross and Cockcroft (1990), held in nine Australian museums, the Natural History Museum, London/United Kingdom, and the Museum für Naturkunde, Berlin/Germany (Table 2.1, Supporting Information S2.1). Cranial maturity was defined as fusion of the posterior maxillae and frontals (*i.e.*, suture closed or closing and immoveable, Ross and Cockcroft 1990). Data from six genera and eight species were collected [*Tursiops* spp. (bottlenose dolphin), *Stenella coeruleoalba* (striped dolphin), *Stenella attenuata* (pantropical spotted dolphin), *Stenella longirostris* (spinner dolphin), *Delphinus delphis* (short-beaked common dolphin), *Steno bredanensis* (rough-toothed dolphin), *Lagenodelphis hosei* (Fraser's dolphin), and *Sousa sahulensis* (Australian humpback dolphin)]. Museum species identifications were verified by MJ using descriptions in Perrin *et al.* (1981), Heyning and Perrin (1994), Jefferson and Leatherwood (1994), Perrin (1998), Archer and Perrin (1999), Wells and Scott (1999) and Jefferson and Karczmarski (2001). Due to taxonomic uncertainty of *Tursiops* in Australian waters (Committee on Taxonomy 2015), specimens were not assigned to species. Holotypes of *T. truncatus* (*Delphinus truncatus*, Montagu 1821) and *T. aduncus* (*Delphinus aduncus*, Ehrenberg 1832) were examined, as were four Australian type specimens: two

syntypes of *Delphinus catalania*, Gray 1862, and two syntypes of *Tursiops maugeanus*, Iredale and Troughton 1934 (Table 2.1, Supporting Information S2.1). One of the *T. maugeanus* syntypes became the holotype of *Tursiops australis* (Charlton-Robb *et al.* 2011).

Table 2.1. Number of skulls measured in the study. Due to missing data, not all specimens were used in each analysis.

Species	Females	Males	Unknown sex	Total 2D (3DGM)
Tursiops spp. undifferentiated	69	60	129	258 (208)
Delphinus truncatus (holotype, *T. truncatus*)	0	0	1	1 (1)
Delphinus aduncus (holotype, *T. aduncus*)	0	0	1	1 (1)
Tursiops australis (holotype)	1	0	0	1 (1)
Tursiops maugeanus (syntype)	0	1	0	1 (1)
Delphinus catalania (syntype)	2	0	0	2 (1)
Stenella attenuata	1	6	11	18 (11)
Stenella longirostris	4	8	3	15 (14)
Stenella coeruleoalba	0	8	0	8 (8)
Sousa sahulensis	1	5	11	17 (17)
Delphinus delphis	0	0	15	15 (15)
Steno bredanensis	2	1	2	5 (5)
Lagenodelphis hosei	2	1	2	5 (4)
Total	82	90	175	347 (285)

Two-dimensional, count and categorical data collection

The 2D data included 47 skull measurements (Fig. 2.1 and Supporting Table S2.2), six categorical variables (Table 2.2), six counts of teeth (included the vestigial anterior teeth, Supporting Table S2.2) and tooth diameter. Twenty-eight of the cranial variables were measured as described in Perrin (1975), three as described in Ross (1977), five as described in Wang *et al.* (2000*b*), and three as described in Kemper (2004). An additional eight measurements were devised for the present study (Supporting Table S2.2). Skull measurements were taken with anthropometers and spreading calipers (cranial height) to the nearest mm. The variables were measured point-to-point as parallel to plane of view, parallel to feature or perpendicular to plane (Supporting Table S2.2).

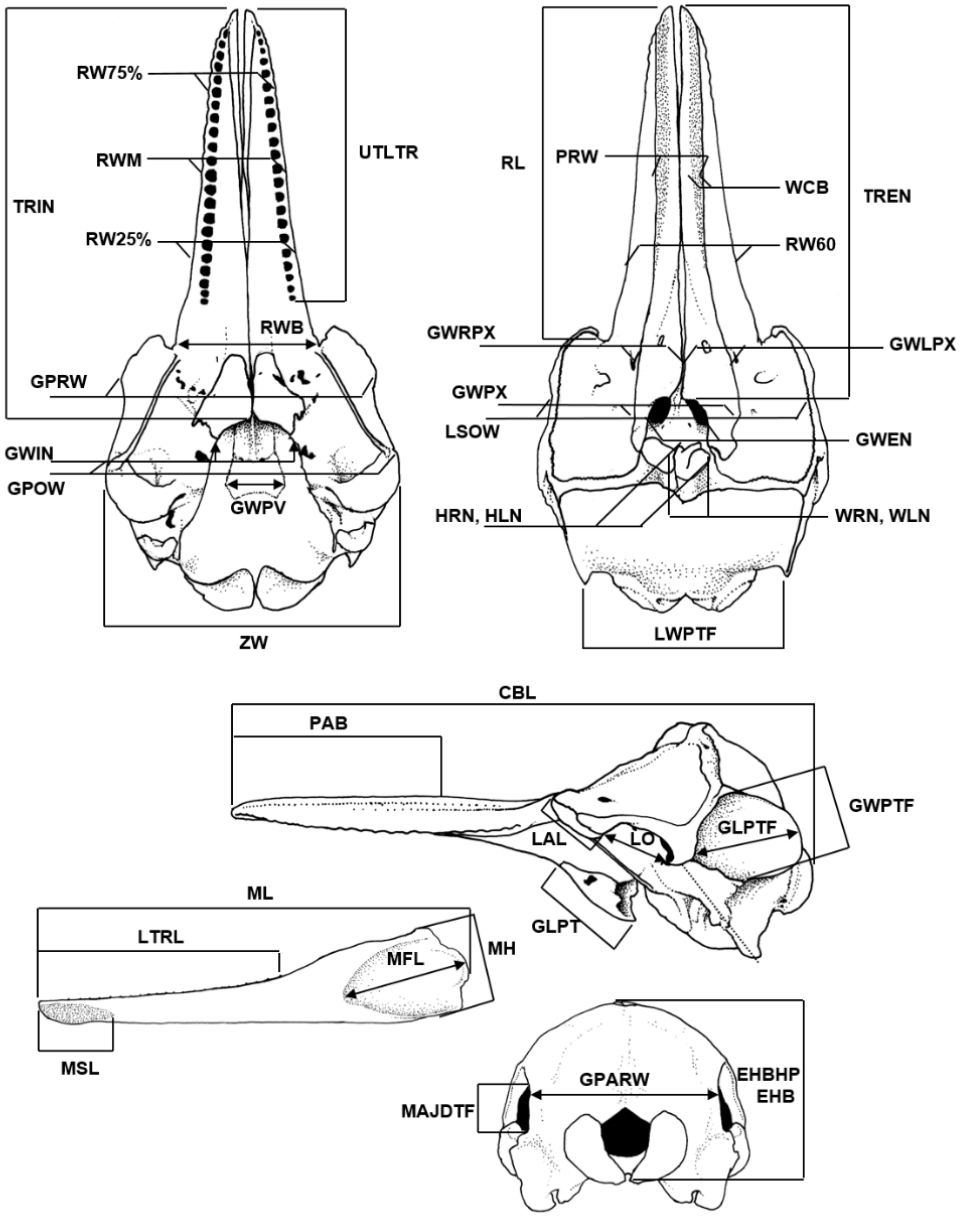

Figure 2.1. Skull measurements used in this study (Supporting Table S2.2), ATW, GWAO, ILB, MINDTF, TRPS, WAS, not illustrated. Specimen is *Tursiops* SAMA M20744 illustrated and modified from Kemper (2004).

Table 2.2. Categorical data of the skull used for the study, modified from or added to Kemper (2004).

Data	Codes
Bone resorption to frontals and pterygoids	1 = none, 2 = slight, 3 = moderate damage, 4 = extensive damage
Extent of the nuchal crest	0 mm = none, 1−5 mm = slight, 6−10 mm = moderate, >10 mm = large
Temporal fossa shape (length/width)	1 = oval, 2 = round
Highest point of skull	1 = nuchal crest, 2 = interparietal of vertex, 3 = frontal, 4 = nasal
Pterygoid hamular ridge shape	1 = no ridge, 2 = slight ridge or ridge just at anterior end, 3 = distinct ridge all along the pterygoid
Premaxilla convexity (in anterior view)	1 = flat, 2 = slight to moderate, 3 = very arched

Three-dimensional data collection

For the 3DGM (Marcus *et al.* 2000, Rohlf 2003), 71 topographically corresponding landmarks were created (Fig. 2.2). Data were collected by MJ using a 3D-digitiser (MicroScribe G2X, Immersion Corporation) in two planes (dorsal and ventral).

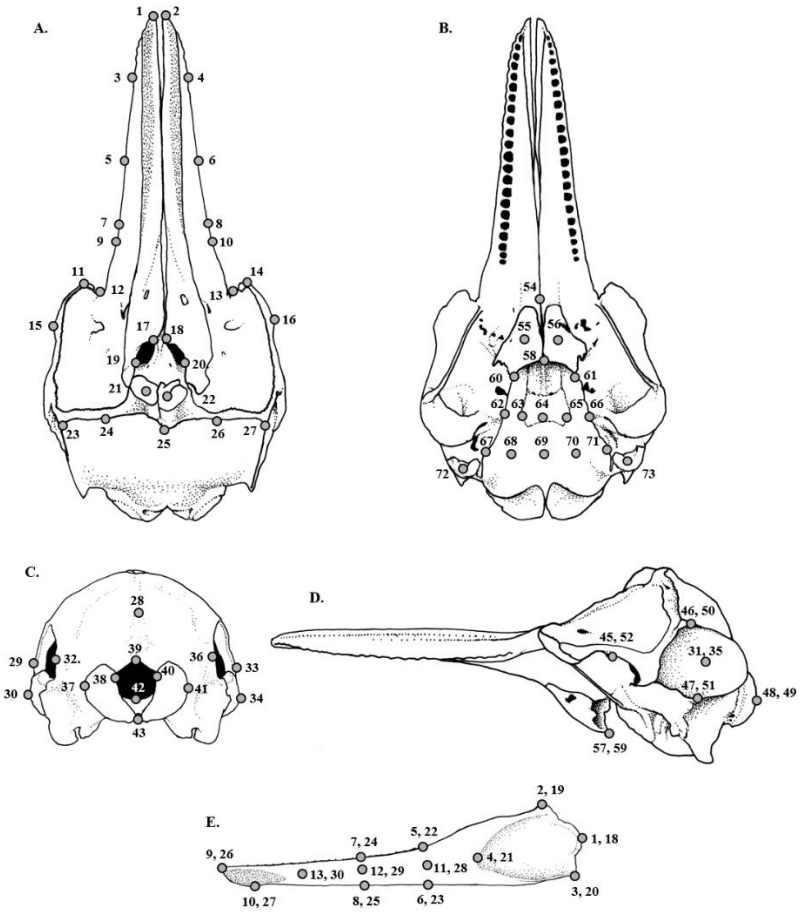

Figure 2.2. Landmark configuration (*n* = 71) for A. dorsal, B. ventral, C. posterior, and D. lateral view of the skull (SAMA M20744 illustrated and modified from Kemper (2004)). Landmarks 35, 49−53, and 59 were located on right side but here are viewed on left.

Statistical Methods

Two software packages were used for 2D analyses, and four software packages for 3DGM (Table 2.3). Data sets were checked for outliers by visual inspection of bivariate plots. Variables with outliners were re-measured to confirm their accuracy. Sexual dimorphism was assessed visually using Principal Component Analyses (PCA) and Hierarchical Component Analyses (HCA). As no sexual dimorphism was apparent for either 2D (PCA, HCA in JMP) or 3DGM (PCA in Morphologica) analyses, females and males were combined in all subsequent analyses. All taxa except *Tursiops* had complete skull data for 2D and 3DGM. 2D variables could have been measured from the 3DGM landmarks, rather than by calipers, by adding more landmarks. However, this was not tested in the present study.

Table 2.3. Software and statistical tests used for the 2D and 3DGM analyses, HCA = hierarchical cluster analysis, DFA = discriminant function analysis, PCA = principal component analysis, GPA = generalised Procrustes analyses, CA = cluster analysis and ANOVA = one-way analysis of variance.

Software	2D tests	3DGM tests
SPSS (version 20.0 Armonk, NY: IBM Corp.)	HCA, DFA, ANOVA	ANOVA
JMP (version 9, SAS Institute Inc., Cary, NC)	PCA	DFA
Morphologica (Paul O'Higgins and Nicholas Jones, University College, London, UK)		GPA, PCA
MorphoJ (Klingenberg 2011)		CA

Two-dimensional, count and categorical data analyses

Multivariate analyses were performed initially including all variables but eliminating *Tursiops* with missing measurement data. The data set was then reanalysed using only the variables that contributed most to the total variation given from the DFA and PCA analyses (Table 2.4), and all *Tursiops* specimens with those data. The final analyses were run using variables contributed most to the total variation given from the DFA and PCA analyses plus variables that had no missing values for any of the specimens, to increase the number of *Tursiops* specimens. Hierarchical cluster analyses used Euclidian distance, while for PCAs other estimation methods such as REML, ML, Robust, Row-wise, and Pairwise distances were used). Principal components with Eigenvalues greater than 1 were retained for varimax rotation, and were rotated to obtain an orthogonal set of fewer variables. Discriminant Function Analyses (DFA) were conducted using default settings to confirm the results from the other multivariate analyses, and to determine which variables contributed the most to the variation. As results from the HCA and PCA exhibited similar patterns, only PCA results are shown.

Multivariate Analysis of Variance (MANOVA) could not be used because the total number of variables was larger than the total number of cases for some species. Therefore, for each variable an ANOVA was used to test for significant differences between species. As the assumption of homogeneity of variance for ANOVA was violated, as determined by Levine's statistic (except for variables HRN, HLN, GWAO, and TLR), species were compared using an unequal variance Welch ANOVA with Games-Howell *post hoc* test.

Three-dimensional data analyses

Landmarks were realigned using Generalised Procrustes Analyses (GPA), which translates, rotates, and scales the specimen landmark configurations (Rohlf and Slice 1990). Reanalysis eliminates size as a contributing factor by translating the centroid of each configuration to the origin and scales the configurations to a common size unit (Adams *et al.* 2004). Clustered landmarks have small centroid sizes, whereas in dispersed ones they are large (Klingenberg 2011).

The GPA data were analysed with PCA, CA, and DFA (default settings) to summarise the variation in shape among taxa and visualise the results. The assumption of homogeneity of variance was violated for ANOVA (centroid size and data that were realigned using GPA), using Levine's with Tukey *post hoc* tests, and so the species were compared using an unequal variance Welch ANOVA with Games-Howell *post hoc* tests.

2.4. Results

Two-dimensional, Count and Categorical Data

The PCA for 2D data is illustrated in Fig. 2.3, with 95% confidence interval ellipses shown for eight taxa. Four of the eight ellipses overlapped, and two plotted adjacent to each other. Specimens of *Tursiops*, including all type specimens, were clearly separated from other taxa. Furthermore, *Stenella longirostris* did not overlap with other species. *Sousa sahulensis* clustered with *Steno bredanensis*, *Stenella attenuata* overlapped with *D. delphis*, and the *L. hosei* ellipse plotted adjacent to *Stenella coeruleoalba*. The DFA confirmed the PCA patterns of these five separate clusters.

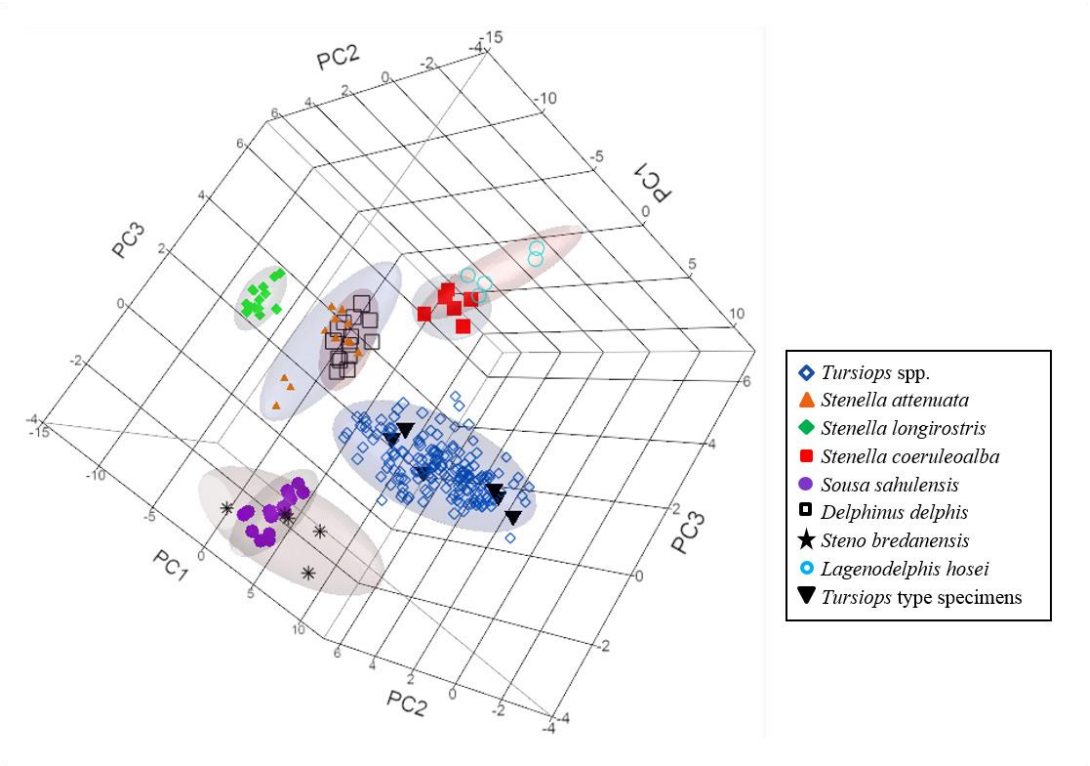

Figure 2.3. PC1, PC2, and PC3 plot of the 2D data for eight taxa from Australia. 95% confidence ellipses illustrated for each taxon.

Results from the ANOVAs showed that all species were significantly different from each other ($P < 0.001$). The Games-Howell *post hoc* test showed that most variables were significantly different when *Tursiops* and other species were compared (Supporting Table S2.1). The *Tursiops* spp. group was most different from *S. longirostris* with 46 of the 47 variables (98%) tested indicating a significant difference, followed by *S. attenuata* and *D. delphis* (41 variables, 87%), *S. sahulensis* (37 variables, 79%), *S. coeruleoalba* (26 variables, 55%), *L. hosei* (24 variables, 51%), and *S. bredanensis* (17 variables, 36%).

The first three PC axes generated by the PCA for 2D data were significantly different from each other (ANOVA PC scores, PC1: $F_{7, 218} = 71.485$, $P < 0.001$, PC2: $F_{7, 218} = 17.730$, $P < 0.001$, PC3: $F_{7, 218} = 170.023$, $P < 0.001$), and contributed most (81.6%) to the total variation (Table 2.4). For PC1 and PC2, width and length variables contributed most to the total variation, respectively (Table 2.4). The DFA weighted CBL, TREN, RL, UTLTR, and LSOW as variables contributing the most to the total variation.

Table 2.4. Two-dimensional variables with PCA loadings for the first three PCs (varimax rotation) and summary statistics. Only variables that had Eigenvalues > 0.7 for one or more PCs are shown.

	Variable	PC1	PC2	PC3
Length				
CBL	Condylobasal length	0.507956	0.747425	0.217081
RL	Rostrum length	0.232349	0.907854	0.203102
TREN	Tip of rostrum to external nares	0.377284	0.824875	0.114278
GLPTF	Greatest length of left temporal fossa	0.471893	0.356097	0.713006
LAL	Length of antorbital process of lacrimal	0.859904	0.234376	0.057338
TRPS	Tip of rostrum to medial palatine suture	0.277250	0.874084	0.270379
UTLTR	Length of upper tooth row to tip of rostrum	0.194810	0.942124	0.132926
Width				
RWB	Rostrum width at base	0.722796	0.352273	0.297458
RW60	Rostrum width at 60 mm from base	0.792198	0.362212	0.357616
RW75%	Rostrum width at 3/4 of rostrum length from base	0.887125	0.130268	0.239613
RWM	Rostrum width at mid-length	0.917196	0.132234	0.220196
RW25%	Rostrum width at 1/4 of rostrum length from base	0.826081	0.252323	0.331540
PRW	Premaxillae width at mid-rostral length	0.763950	0.274102	0.355916
WCB	Width of cancellous bone on maxilla at mid-rostrum	0.734095	0.398140	-0.162847
GPRW	Greatest preorbital width of skull	0.824984	0.266407	0.404523
LSOW	Least supraorbital width	0.808379	0.257718	0.401545
GWPX	Greatest width of premaxillae	0.729395	0.329642	0.286051
ZW	Zygomatic width of skull	0.798475	0.319266	0.418831
GPOW	Greatest postorbital width of skull	0.800029	0.309804	0.419333
GPARW	Greatest width across parietals	0.719628	0.123565	0.404196
LWPTF	Least width between posterior borders of temporal fossa	0.770372	-0.090237	0.087722
GWPTF	Greatest width of left temporal fossa	0.289163	0.389971	0.779831
GWIN	Greatest width of internal nares	0.823562	0.309834	0.307668
ATW	Alveolar tooth width at mid-rostrum	0.494072	0.245559	0.703643
WAS	Width of alisphenoid at suture with the basisphenoid	0.769738	0.394575	0.370525
GWPV	Greatest width of posterior flange of vomer	0.768857	0.384046	0.121505
Height and diameter				
EHB	External height of braincase	0.735545	0.360730	0.428148
EHBHP	External height of braincase to highest point	0.762980	0.367712	0.403165
MAJDTF	Major diameter of (anterior) temporal fossa	0.357747	0.141506	0.810354
MINDTF	Minor diameter of (anterior) temporal fossa	0.118986	0.817795	0.329635
Eigenvalue		27.74	3.43	2.30
Total variance		67.7%	8.4%	5.6%
Cumulative variance		67.7%	76.0%	81.6%

The number of maxillary teeth (TUL and TUR) and the total number of teeth were significantly different when *Tursiops* spp. and other taxa were compared (Supporting Table S2.1). Mean total tooth count was highest in *D. delphis* (Table 2.5). *Steno bredanensis* and *Tursiops* spp. had the lowest number of teeth both totally (Teeth tot: $F_{1, 187} = 2.95$, $P < 0.001$) and on each side of the maxilla (TUL: $F_{1, 231} = 2.54$, $P < 0.001$, TUR: $F_{1, 231} = 4.34$, $P < 0.01$).

Table 2.5. Total tooth count (including mandible and maxillae) for taxa studied. SD = standard deviation.

Species	N	Range	Mean	SD
Steno bredanensis	6	90–96	93.3	2.2
Tursiops spp.	158	81–114	98.4	5.5
Sousa sahulensis	20	123–135	128.6	3.3
Lagenodelphis hosei	5	154–160	157.0	2.4
Stenella attenuata	15	150–172	161.9	7.9
Stenella longirostris	15	167–198	181.5	14.9
Stenella coeruleoalba	8	171–197	183.6	8.9
Delphinus delphis	15	174–210	193.2	12.3

Some visually compared categorical variables helped to separate taxa (Table 2.2). Pterygoid shape was significantly different between *Tursiops* spp. and other taxa ($F_{7, 316} = 7.12$, $P < 0.001$). The hamular crest of the pterygoid was more pronounced for *Tursiops* spp. compared to *S. attenuata* ($P < 0.001$), *S. coeruleoalba* ($P < 0.001$), and *D. delphis* ($P < 0.001$) but more flattened compared to *S. sahulensis* ($P < 0.05$). The premaxilla convexity ($F_{7, 339} = 12.95$, $P < 0.001$) was more pronounced for *Tursiops* spp. than *S. sahulensis* ($P < 0.001$), *S. bredanensis* ($P < 0.001$), and *L. hosei* ($P < 0.001$), but more flattened for *D. delphis* ($P < 0.001$). Development of the nuchal crest ($F_{7, 336} = 10.29$, $P < 0.001$), was less pronounced in *Tursiops* spp. compared to *S. coeruleoalba* ($P < 0.05$), *S. sahulensis* ($P < 0.001$), *L. hosei* ($P < 0.001$), and *D. delphis* ($P < 0.05$).

Three-dimensional Data

The PCA for 3DGM data is illustrated in Fig. 2.4, with 95% confidence interval ellipses shown for eight taxa. Four of the eight ellipses overlapped, and three plotted adjacent to other ellipses. *Tursiops* was clearly separated from all other genera. The S. *longirostris* ellipse plotted adjacent to *S. attenuata* and *D. delphis*. The *L. hosei* ellipse plotted adjacent to *S. coeruleoalba*, *S. attenuata* overlapped with *D. delphis*, and *S. sahulensis* clustered with *S. bredanensis*.

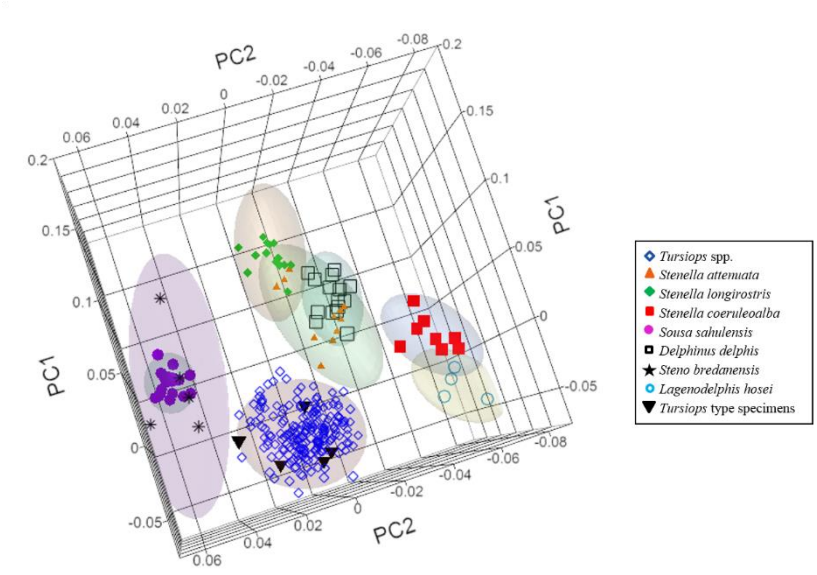

Figure 2.4. PC1, PC2, and PC3 plot of the 3DGM data for eight taxa from Australia. 95% confidence ellipses illustrated for each taxon.

The 3DGM data showed that all taxa differed significantly from each other for both data treatments (centroid ANOVA, $F_{7, 272} = 18.131$, $P < 0.001$; GPA ANOVA, $F_{7, 272} = 38.31$, $P < 0.001$). The *post hoc* test based on the centroid size showed that *Tursiops* spp. differed significantly from *S. attenuata* ($P < 0.001$), *S. coeruleoalba* ($P < 0.05$), *S. longirostris* ($P < 0.001$), *L. hosei* ($P < 0.001$), and *D. delphis* ($P < 0.001$), but not from *S. sahulensis* and *S. bredanensis* ($P > 0.05$).

The first four PC axes generated by the PCA for 3DGM data were significantly different from each other (ANOVA PC scores, PC1: $F_{7, 272} = 191.664$, $P < 0.001$, PC2: $F_{7, 272} = 120.286$, $P < 0.001$, PC3: $F_{7, 272} = 12.187$, $P < 0.001$, PC4: $F_{7, 272} = 5.439$, $P < 0.001$), and accounted for 80.5% of the total shape variation. PC1 and PC2 explained 40.6% and 12.8% of the total variation, respectively. PC1 primarily described rostrum and skull length and width (Fig. 2.5). Along the PC2 axis (Fig. 2.6), the shape of the cranium varied from round (O) to angular (A) from a posterior view, and the shape of the temporal fossa dorsally. *Steno bredanensis* and *S. sahulensis* were O-shaped, while crania of *S. coeruleoalba* and *L. hosei* were A-shaped from a posterior view. The remaining taxa were intermediate. Other features were shared between the cranial shape groups. For example, *S. bredanensis* and *S. sahulensis* had narrow rostra and short distances between the posterior borders of temporal fossae (points 32 and 36, Fig. 2.2). In contrast, skulls of *S. coeruleoalba* and *L. hosei* had wide rostra and larger distances between the posterior borders of temporal fossae. Skulls of *Tursiops* spp. had the shortest and the widest rostra, and largest crania relative to the length of the rostrum compared with *S. attenuata*, *D. delphis*, and *S. longirostris*. The DFA performed on the first 49 PC scores (95% of the total variation), confirmed the 2D PCA patterns of a division of the eight taxa into five clusters.

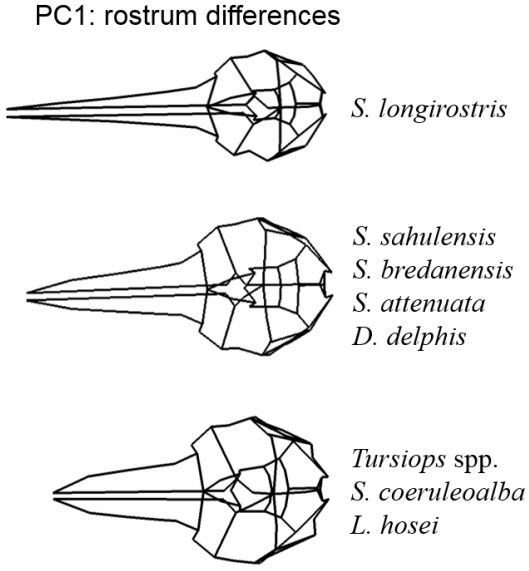

Figure 2.5. Simplified shape difference between eight taxa along the PC1 axis for dorsal views of rostral shape.

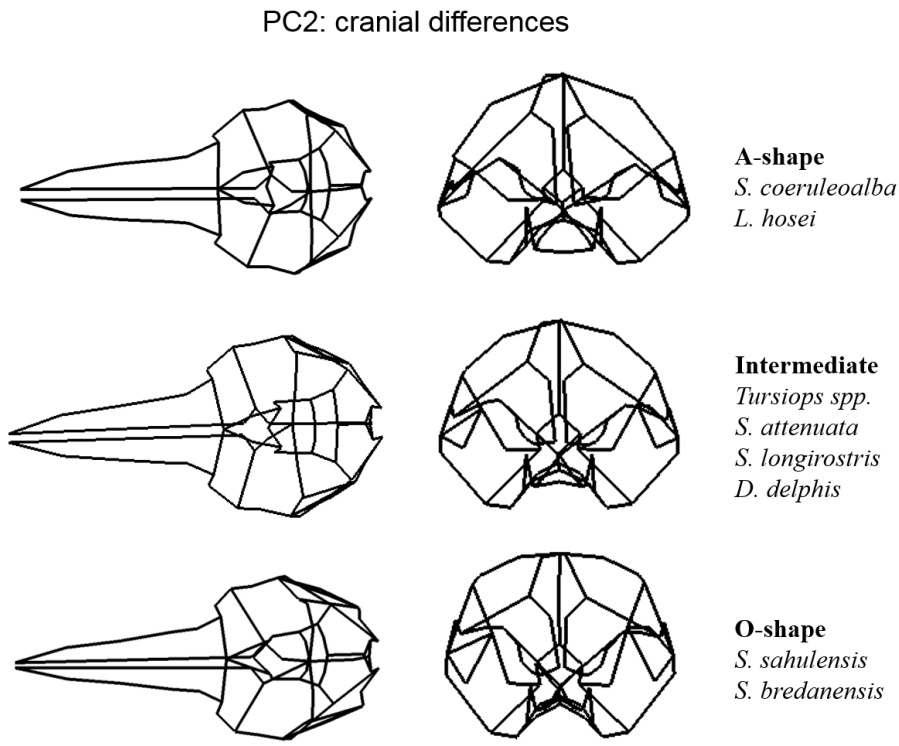

Figure 2.6. Simplified shape difference between eight taxa along the PC2 axis for dorsal and posterior view of the cranial shape.

2.5. Discussion

A comprehensive detailed morphological comparison of delphinid skulls has previously not been published, and diagnostic cranial and/or postcranial characters to distinguish Delphininae have not been defined (Perrin *et al.* 2013). Several morphological classifications of taxa in the family Delphinidae have been suggested (Rice 1998). Most agreed that *Tursiops*, *Stenella*, *Delphinus*, and *Lagenodelphis* are members of the subfamily Delphininae (Kasuya 1973, Barnes 1990, Buchholtz and Schur 2004). Perrin (1989) concluded that *Sousa* and *Steno* should be assigned to *Steninae*. Our study compared skull morphology of six delphinid genera occurring in Australian waters. The results showed a clear separation between species of *Tursiops* and other taxa, and a separation of *Sousa* and *Steno* from other genera. The three *Stenella* species, did not form a separate cluster, overlapping with other genera. Shape of the cranium from a posterior view and shape of the rostrum from a dorsal view were important drivers, and tooth counts were important in distinguishing species that overlapped in the 2D PCA. Type specimens of *Tursiops* spp. were clearly aligned with that genus.

Many dolphin species have a global distribution in which they experience different environments (Rice 1998) with no obvious geographical barriers (Norris 2000). Morphological variation has been shown to be linked to adaptations to the environment (Perrin 1984, Heyning and Mead 1996, Rice 1998, Werth 2006*b*), and sometimes differs over short distances (Rice 1998). Such variation may be considerable within and between populations (Perrin 1984). In marine mammals, one of the primary drivers of adaptation

include feeding (Heyning and Mead 1996, Werth 2000, 2006*a*, *b*). The taxa studied in the present study have ecological and distributional differences (Rice 1998, Reeves *et al.* 2002), for example in the way prey are captured and swallowed (Werth 2006*a*, *b*), and living in waters at different water depths (Rice 1998, Reeves *et al.* 2002). Body size, and shape (3DGM) and size (2D) of the head may influence the mechanics of capturing prey (Barnes 1990, Heyning and Mead 1996, Rice 1998, Werth 2000, 2006*a*, *b*). For instance, the ability to capture food in cetaceans relates in part to the shape of the rostrum and size, form and number of teeth (Rice 1998, Rommel *et al.* 2002). In the present study, differences were found in rostrum length and width (2D and 3DGM) and number of teeth. These have been related to different diets in odontocetes (Rice 1998, Rommel *et al.* 2002). Delphinids with long, narrow rostra and many teeth, such as *S. attenuata* (138-190 teeth), *S. longirostris* (166-252 teeth), and *S. sahulensis* (120-152 teeth) (Reeves *et al.* 2002), are grasp feeders and prey mainly on fish (Werth 2006*b*). On the other hand, *S. bredanensis* (76-108 teeth) and *Tursiops* spp. (76-116 teeth) (Reeves *et al.* 2002) have short, broad rostra and fewer teeth, are grasp feeders and have a catholic diet including cephalopods and crustaceans (Ballance 2009, Werth 2006*b*). Differences in pterygoid shape and premaxilla convexity that were found in the present study are also likely related to feeding mechanics (Rommel *et al.* 2002). The O-*vs.* A-shape difference found (3DGM) between taxa in the present study is likely to be linked to their distributional differences (Rice 1998, Reeves *et al.* 2002). de Araujo Monteiro-Filho et al. (2002) found that inshore *Sotalia* have a rounder skull shape compared to the angular offshore *Sotalia*. Similar patterns could be found in the current study. The crania of *S. bredanensis* and *S. sahulensis* were round from a posterior view, and these taxa are largely confined to close inshore waters, and typically occurs seaward of continental or island shelves respectively (Rice 1998, Reeves *et al.* 2002), while the crania of *S. coeruleoalba* and *L. hosei* were angular from a posterior view, and both taxa prefer deep waters (Rice 1998, Reeves *et al.* 2002). These shape differences shows the influence of distributional variations, and might be related to food preferences. Ecological diversity has been found between inshore and offshore *Tursiops* spp. (Mead and Potter 1995, Wang *et al*. 2000*b*, Gibbs *et al.* 2011), where *T. aduncus* feed primarily on benthic or reef dwelling fish, while *T. truncatus* feed primarily on schooling mesopelagic or epipelagic fish (Wang *et al.* 2000*b*).

The phylogenetic relationships among delphinids have been widely debated (LeDuc *et al.* 1999, McGowen 2011, Perrin *et al.* 2013), as results between morphological and molecular analyses are inconsistent (Perrin *et al.* 2013). Classification based on morphological similarity can be due to function rather than ancestry (Perrin *et al.* 2013). Moreover, hybridisation and introgression may mix characters between species (Brown *et al.* 2014). From a morphological perspective, the biggest challenge is that a comprehensive study including all delphinids is lacking (Perrin *et al.* 2013). However, previous morphological work has consistantly distinguished *Tursiops* from other genera (Perrin 1975, Wells and Scott 1999, Perrin 2001, Shirakihara *et al.* 2003). Interpretation of molecular data might be hampered by incomplete linage sorting (Nikaido *et al.* 2007), frequently observed in delphinids due to their recent and rapid radiation (McGowen 2011).

The inconsistency between results based on genetic studies supporting either monophyly (McGowen *et al.* 2009, Steeman *et al.* 2009) or polyphyly (LeDuc *et al.* 1999, Kingston *et al.* 2009, Xiong *et al.* 2009) for *Tursiops*, shows the necessity to use several genetic markers with different evolutionary history to make sound phylogenetic inferences. However, the taxonomic inconsistency of delphinids will only be overcome by integrating genetic and morphological methods (Chiari *et al.* 2009, Kurihara and Oda 2007), and by incorporating samples from a large geographical area or even different ocean basins. Our study challenges previous genetic studies identifying the genus *Tursiops* as polyphyletic, with *T. aduncus* closer to *Stenella* and *Delphinus* than to other species of *Tursiops*. From a morphological point of view, the congruence of the 2D and 3DGM methods confirmed species of *Tursiops* as a monophyletic group with no overlap with other taxa. Species within the genus *Tursiops* did not show a clear separation, but research is currently underway to clarify this in Australian waters.

2.6. Acknowledgments

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Chapter 3

Taxonomy and distribution of bottlenose dolphins in Australian waters: an osteological clarification

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Author contributions:
Maria Jedensjö conceived the study, conducted data collection from the museums, conducted statistical analyses, and wrote the manuscript.
Marco Milella and Erik P. Willems conducted statistical analyses and edited the manuscript.
Catherine M. Kemper and Michael Krützen conceived the study and edited the manuscript.

3.1. Abstract

Species relationships in the genus *Tursiops* are controversial. We carried out a comprehensive osteological study of 264 skulls, including type specimens, and 90 postcranial skeletons of *Tursiops* spp., to address taxonomic uncertainties in Australia using two-dimensional measurements (2D), and three-dimensional geometric morphometrics (3DGM), tooth counts, and categorical data. Analyses provided support for the presence of two forms, aligned to *T. aduncus* and *T. truncatus*, including type specimens. *Tursiops australis* fell well within *T. truncatus* for both methods. Thirteen *Tursiops* spp. specimens were of intermediate size for 2D methods and could not be assigned to either of the two groups. No *T. australis* was amongst the intermediates. For 3DGM data there was a strong allometric influence and few non-allometric differences between species. Length and width of the cranium and rostrum were important discriminating variables. *Tursiops aduncus* was smaller, had more teeth, fewer vertebrae, and more erosion on the pterygoids and frontals than *T. truncatus*. Overall cranium shape was round in *T. aduncus* and angular in *T. truncatus*. Skull length of *T. aduncus* was smaller in low than in high latitudes. This study highlights the importance of large sample size, multiple analytical analysis methods and extensive geographical coverage when undertaking taxonomic studies.

3.2. Introduction

The genus *Tursiops* belongs to the most speciose family of Cetacea, the Delphinidae (Rice 1998). Relationships within this family have been widely debated (McGowen 2011, Perrin et al. 2013). For example, genetic studies concluded that *Tursiops aduncus* and *Tursiops truncatus* may be more closely related to other genera than to each other (LeDuc et al. 1999, Kingston et al. 2009, Moura et al. 2013). The challenge in understanding relationships within delphinids may be due to their rapid radiation (McGowen 2011, Perrin et al. 2013), difficulties in resolving short branches produced by cladistic analyses (McGowen 2011), incomplete lineage sorting (Nikaido et al. 2007, Perrin et al. 2013), and the difficulty identifying clear diagnostic morphological characters (Buchholtz and Schur 2004, Amaral et al. 2009, Perrin et al. 2013). However, linear and geometric morphometric analysis show evidence of clear separation between *Tursiops* and some other delphinid genera (Amaral et al. 2009, Jedensjö et al. 2017).

At least 20 *Tursiops* species have been named (Rice 1998), but only two are currently recognised worldwide (Committee on Taxonomy 2018), *Tursiops truncatus* Montagu, 1821, the common bottlenose dolphin, and *Tursiops aduncus* Ehrenberg, 1832, the Indo-Pacific bottlenose dolphin. Kinze (2018) concluded that *Tursiops tursio* (Gunnerus, 1768) predates *Tursiops truncatus* but the present study will use the more universally adopted latter name. Another species, *T. australis*, the Burrunan dolphin, has been named from Australia (Charlton-Robb et al. 2011), but has not been widely accepted as a distinctive nominal species of *Tursiops* (Committee on Taxonomy 2018). Some authors (Möller et al. 2008, Moura et al. 2013), use the common name southern Australian bottlenose dolphin (SABD, for abbreviations see Supporting Table S3.1), which is assumed to be *T. australis*.

Previous morphological studies have confirmed the occurrence of two *Tursiops* species in South Africa (Ross 1977, 1984), the Indian and western Pacific Ocean (Kurihara and Oda 2007), China (Wang et al. 2000*a*, 2000*b*; Natoli et al. 2004), Japan (Kakuda et al. 2002), and Australia (Hale et al. 2000, Kemper 2004). Distinction between these is sometimes based on size (Ross 1977, Wang et al. 2000*a*), where body length of *T. truncatus* is usually greater than 2.4 m (Wells and Scott 1999, Reeves et al. 2002), and *T. aduncus* is less than 2.6 m (Reeves et al. 2002). Skull characteristics have also proven informative, but without complete concordance between geographic regions (Ross 1977, Wang et al. 2000*a*), where skull size is generally larger in *T. truncatus* (Ross 1977, Wang et al. 2000*b*, Kemper 2004). However, an overlap in skull size has been reported for the China Sea (Wang et al. 2000*a*, 2000*b*), and South Australia (Kemper 2004).

Ross and Cockcroft (1990) examined external morphology and skeletons of *Tursiops* from Australia and provided evidence for a single species, *T. truncatus*, with clinal variation from north to south. Small specimens were found in the warmer waters of northern Australia and larger ones in the colder south. Hale et al. (2000), described two distinct forms of *Tursiops* in south-eastern Queensland; a large, unspotted form in waters greater than 30 m depth (*T. truncatus*), and a small, spotted form in waters less than 30 m (*Tursiops* cf. *aduncus*). Using multivariate analyses of skull measurements and features, Kemper (2004) found support for

two morphotypes of bottlenose dolphins in South Australia. These had affinities with *T. aduncus* and *T. truncatus*. There is a need for a large-scale investigation to confirm the presence of these two species from other locations.

Bottlenose dolphin type specimens collected from Australia include two skulls of *Delphinus catalania* Gray, 1862, collected by John MacGillivray in 1860 at Cape Melville, Queensland, and two skulls of *Tursiops maugeanus* Iredale and Troughton, 1934 collected in 1960 and 1965 at Tamar River, Tasmania. Hershkovitz (1966) synonymised these species into *T. truncatus aduncus*.

The aim of the present study was to investigate the taxonomy and distribution of bottlenose dolphins in Australia using a large data set from a broad geographic area. Classical, linear two-dimensional (2D) data were collected from skulls and counts were made of vertebrae. These data allowed comparison with previous studies. Three-dimensional geometric morphometric (3DGM) data were collected from skulls to provide a more detailed analysis of the relative contribution of allometric and non-allometric factors. Type specimens relevant to the Australian region were included in the study.

3.3. Material and Methods

Specimens

Data were obtained from Australian specimens (n = 264) held at nine Australian museums; the Natural History Museum, London, UK; and the Museum für Naturkunde, Berlin, Germany (Table 3.1 and Supporting Information S3.2). These were collected between 1862 and 2009. Only cranially mature specimens were examined, in which the posterior maxillae were securely fused (i.e. no movement) to the cranium (Ross and Cockcroft 1990), and the suture closed or closing (Kemper 2004). Twenty-two specimens were previously identified as *T. australis* (Supporting Information S3.2) by Charlton-Robb et al. (2011). Holotypes of *T. truncatus* (*Delphinus truncatus* Montagu, 1821), and *T. aduncus* (*Delphinus aduncus* Ehrenberg, 1832) were examined, as well as type specimens of other *Tursiops* taxa described from Australia, (i.e. *Delphinus catalania* Gray, 1862 and *Tursiops maugeanus* Iredale and Troughton, 1934; Table 3.1 and Supporting Information S3.2). It is worth noting that the one of the *T. maugeanus* syntypes became a junior synonym of *T. truncatus*, while the other became a paralectotype, *T. australis* (Charlton-Robb et al. 2011).

Two-dimensional, count, and categorical data collection and statistical protocols

Two-dimensional data (Table 3.1, Supporting Information S3.2) were collected by MJ and CMK, including 52 skull measurements (Fig. 3.1, Supporting Table S3.3), 11 counts (Supporting Table S3.4) and 10 categorical variables (Supporting Table S3.4). Most specimens from Western Australian Museum and South Australian Museum were measured by CMK (excluding counts and categorical variables), while MJ measured the specimens from other museums and type specimens. To calibrate measuring methods, MJ was trained by CMK, and a Student's paired t-test was used to test the differences between these. All skulls were measured twice by each person.

Table 3.1. Number of *Tursiops* spp. specimens examined in the study. Two-dimensional linear measurements (2D) and three-dimensional geometric morphometric (3DGM) data were obtained. Due to missing data, not all specimens were used in each analysis. F = number of females, M = number of males, and UK = unknown sex.

Specimens	F	M	UK	Tot 2D	Tot 3DGM	Vertebral count	Categorical data	Tooth count
Tursiops spp.	64	57	116	237	197	83	148	148
Tursiops australis	5	3	13	21	11	6		19
Delphinus truncatus (holotype, *T. truncatus*, NHMUK 353a)	0	0	1	1	1	0	1	1
Delphinus aduncus (holotype, *T. aduncus*, BZM 66400)	0	0	1	1	1	0	1	1
Tursiops australis (paralectotyp, *T. truncatus* QVM 1365)	1	0	0	1	1	0	1	1
Tursiops maugeanus (junior synonym of *T. truncatus, T. truncatus*, QVM 1360)	0	1	0	1	1	1	1	1
Delphinus catalania (syntype, *T. aduncus*, NHMUK 1862.6.6.13, 14)	2	0	0	2	1	0	2	1
Total	72	61	131	264	213	90	154	172

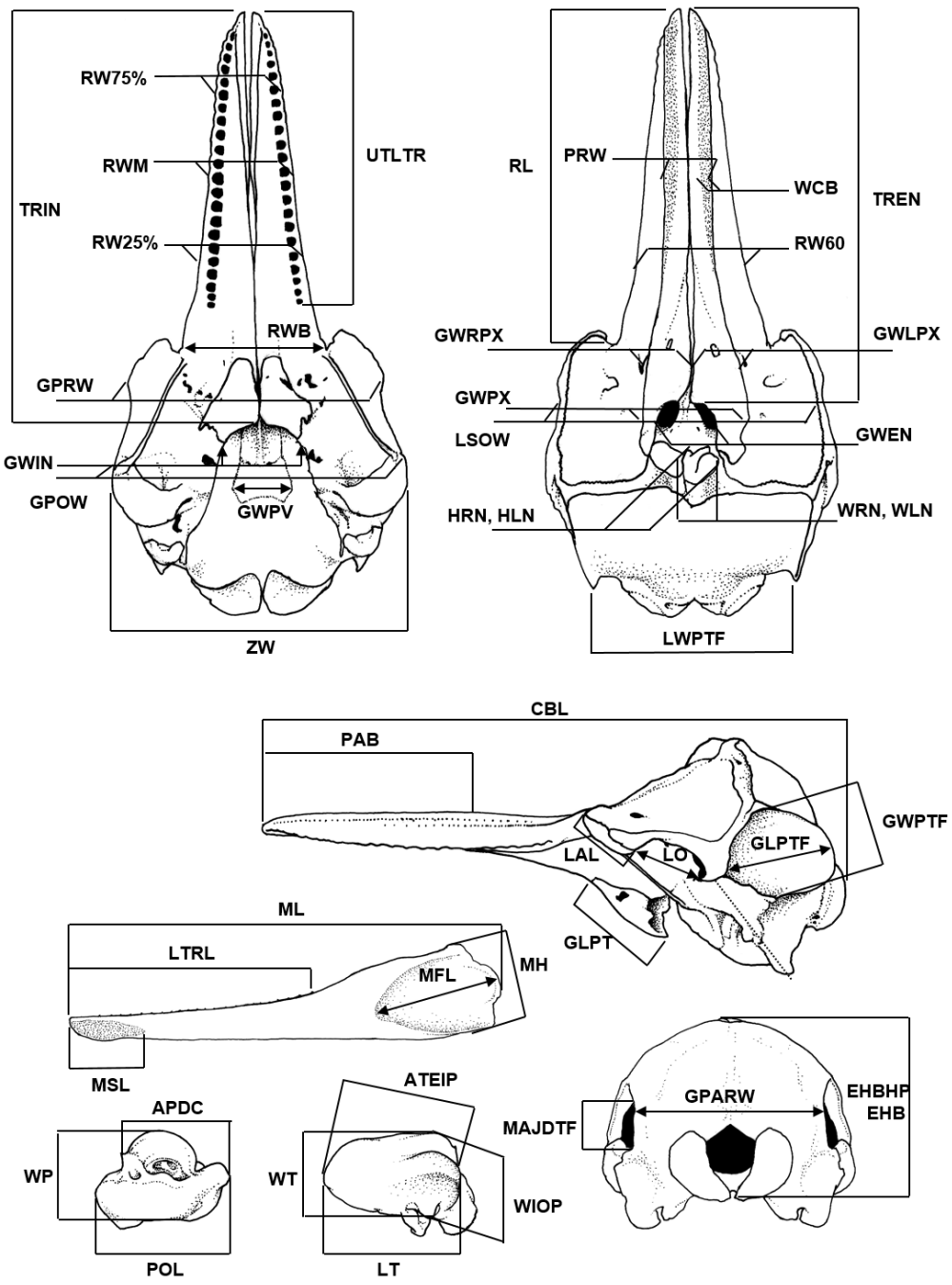

Figure 3.1. Skull measurements used in this study, ATW, GWAO, ILB, MINDTF, TLL, TLR, TRPS, TUL, TUR, WAS not illustrated. For abbreviations see Supporting Table S3.1. Illustrated skull is *Tursiops* SAMA M20744, modified from Kemper (2004).

Ten variables (GLPT, GWIN, GWPX, LAL, LO, MINDTF, RW60, RW75%, RWB and RWM) showed a significant difference and were therefore re-measured by MJ for all specimens from Western Australian Museum and South Australian Museum. Skull measurements were taken with anthropometers and spreading calipers to the nearest mm. Variables were measured point-to-point parallel or perpendicular to the plane of view, or parallel to feature being measured (Figure 3.1 and Supporting Table S3.3). Categorical data

were assessed visually and included four that were used by Charlton-Robb et al. (2011). Count data were number of teeth in each tooth row (including vestigial anterior teeth, Supporting Table S3.4), and seven vertebral counts (Supporting Table S3.4). The latter were collected only from full vertebral columns (Table 3.1, assessed by lining up the vertebrae), of which most (58) were from South Australia. The two small, triangular, fused, terminal caudal vertebrae were counted as one.

The 2D data were checked for outliers by visual inspection of bivariate plots and these re-measured. Multivariate normality was assessed for each variable by examining box-whisker plots and histograms. None of the variables were skewed enough to warrant transformation. Sexual warrant dimorphism was tested using multivariate analysis of variance (MANOVA in SPSS version 20.0 Armonk, NY: IBM Corp.) and Principal component analysis (PCA).

Initial multivariate analyses were performed on 218 specimens for which complete data were available. In order to not over-inflate the importance of size in the grouping of specimens by the analyses of the original data, and to deal with potentially skewed data, cluster and discriminant function analyses were also performed on log transformed data and PC scores. Three analyses were performed to discriminate groups: K-means (2−3 groups in JMP), hierarchical cluster analyses (HCA, using Euclidean distance in SPSS), and discriminant function analysis (DFA, SPSS) to confirm results and to identify measures which drove separation of groups. To increase sample size, the data set was then reanalysed using only the most important variables (n = 25) as determined by stepwise DFA. Principal component analysis (using Restricted Maximum Likelihood, Maximum Likelihood, Robust, Row-wise and Pairwise estimation methods in JMP) were performed to confirm groups and visualise results. MANOVA was used to test for statistical significant differences between *T. australis* and identified groups as determined by the multivariate analyses. Student's *t*-tests and Mann-Whitney *U*-tests were used to identify statistically significant morphological (count and categorical data Supporting Table S3.4) differences between groups.

Geometric morphometrics data collection and statistical protocols

A set of 73 cranial landmarks was collected from 202 specimens (Fig. 3.2, Table 3.1, Supporting Table S3.5) using a 3D-digitiser (MicroScribe G2X, Immersion Corporation). These were subjected to generalised Procrustes analysis (GPA), which scales all specimens to the same size and superimposes them by minimising the sum of squared deviations between landmark configurations. Centroid size (the square root of the sum of square distances of each landmark to its mean) was then used as proxy for the size of each individual.

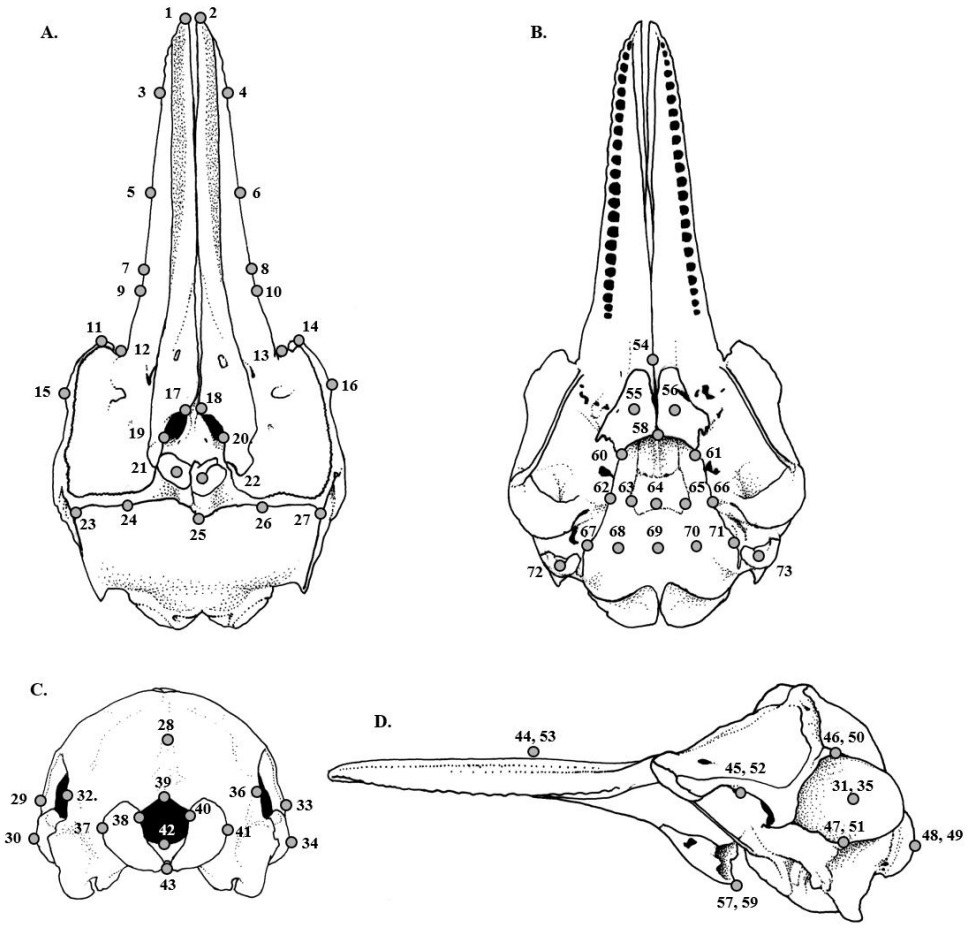

Figure 3.2. Landmark configuration (*n* = 73) for A. dorsal, B. ventral, C. posterior and D. lateral views (Supporting Table S3.5). Landmarks 35, 49−53 and 59 were located on right side but here are viewed on left. Illustrated skull is *Tursiops* SAMA M20744, modified from Kemper (2004).

After GPA, the following steps were performed:

1) The amount of variance due to sexual dimorphism, directional asymmetry, and size was quantified by means of Procrustes ANOVA.

2) The presence of patterns in the data was assessed by means of hierarchical cluster analyses (HCA, Ward and UPGMA methods) and PCA. Number of optimal clusters was chosen using the function fviz_nbcust in the package factoextra for R version 3.7.1.

3) In order to control for the effect of allometry on the clustering of the samples, HCAs were performed twice. Firstly, performed PCA using the original coordinate configurations, then using all principal components (PC) as input for the cluster analyses. The second HCA was performed after following a PCA on the Procrustes shape coordinates augmented with the natural logarithm of centroid size (Mitteroecket et al. 2004), and excluding then the first PC from the cluster analyses. The latter step allowed considering only shape changes uncorrelated to size.

4) A permutational analysis of multivariate variance PERMANOVA (10,000 permutations) was used to test for statistically significant differences between the clusters identified in step 3.

Geometric morphometric analyses were carried out in MorphoJ 1.06 (Klingenberg 2011) PAST, and R (v. 3.3.1, R Core Team, 2016), using the packages geomorph, Morpho, factoextra, vegan and MASS (Venables and Ripley 2002, Schlager 2017, Kassambara and Mundt 2017, Adams et al. 2018). Visualisation of shape changes was obtained by warping a wireframe representation of a generic *Tursiops* cranium via a thin-plate-spline (TPS) algorithm in Morphologika (v2.5).

Geographical analyses

Correlations between cranial shape (3DGM Procrustes residuals data) and geographic distances were tested using a Mantel test in the R package ecodist (Goslee and Urban 2007). Pearson correlation coefficients and 95% confidence intervals (*n* bootstraps = 1,000) were obtained, and assessed for statistical significance using 10,000 permutations. The 3DGM Procrustes data were first transformed into Procrustes residuals data that were converted into a pairwise matrix (Euclidean index setting) using PAST (v 3.14, Hammer et al. 2001). Geographic distances between specimens were calculated as dyadic least-cost path distances using the 'gdistance' package (van Etten 2015) in R 3.3.0 (R Core Team 2016). Distance matrices were defined such that only travel through oceanic water was possible (at a uniform cost), with shorelines demarcated by the SRTM Water Bodies data set (Environmental Systems Research Institute 2008), projected in the Geocentric Datum for Australia (GDA94) at a raster resolution of 10 km.

3.4. Results

Two dimensional, count and categorical data

No sexual dimorphism was detected in the 2D measurements (MANOVA, $F_{76, 268} = 1.303$, $P < 0.05$, female = 51, male = 55, PCA in Fig. 3.3), therefore sexes were combined in all subsequent analyses.

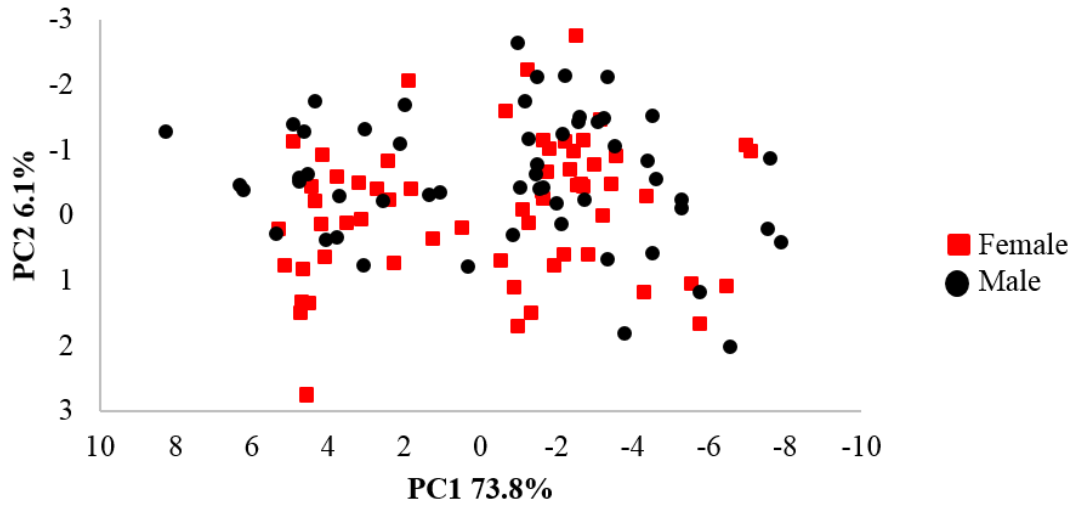

Figure 3.3. Principal component analysis (PC1 and PC2) of *Tursiops* spp. skull two-dimensional data to illustrate lack of sexual dimorphism. Only specimens with known sex are included.

K-means and HCA on the original data separated most specimens into two groups (2D-1 and 2D-2) and their assignment was the same for all tests. No sexual dimorphism was detected when testing within each group (MANOVA 2D-1, $F_{16, 72} = 1.347$, $P < 0.05$; MANOVA 2D-2, $F_{9, 42} = 2.00$, $P < 0.05$). Specimens identified as *T. australis* were well embedded in *T. truncatus* for both analyses. Thirteen specimens aligned with different groups in the tests (Table 3.2), and are here defined as intermediate (Supporting Table S3.2). Cluster analyses on the log transformed data and PC scores showed that specimen assignment was consistent with the results on the original data for most specimens, including *T. australis*, but did not perform better than the original data. When original data follow a normal distribution, as in the present study, it is recommended these are used because transformation can result in data being variable and skewed (Changyong et al. 2014). For this reason, only analyses using original data are presented in the results.

Table 3.2. Comparison of clustering consistency of *Tursiops* spp. specimens between three two-dimensional analyses, 0 % = no specimens in same group, 100 % = all specimens in same group.

	HCA	k-means	DFA
HCA	—	96.6 % (n = 9)	96.6 % (n = 9)
k-means	—	—	97 % (n = 8)

Principle component analysis is a useful way to visualise the data in two-dimensional space as it illustrates the relationship of the groups and intermediates (Fig. 3.4A). Note the overlap between 2D-1 and 2D-2. A comparison was also made for the 44 specimens examined by Charlton-Robb et al. (2011), and used for their hierarchical multivariate cluster analyses, where all 5 *T. aduncus*, 8/13 *T. truncatus*, and 21/26 *T. australis* specimens were used in the present study (Fig. 3.4B). The same comparison was also made for the 84 specimens examined by Kemper (2004), where 27/59 *T. aduncus* and 22/25 *T. truncatus* specimens were used in the present study (Fig. 3.4C). Thus is appears that 2D-1 represents *T. aduncus*, and 2D-2, *T. truncatus*. Importantly, *T. australis* specimens fell entirely within the *T. truncatus* cluster (Fig 3.4).

A similar pattern was apparent when many variables (e.g. GPOW, Fig. 3.5) were plotted against CBL, in this case showing the importance of skull size in discriminating groups. The *T. aduncus* group contained small skulls, including the type specimen of *D. catalania*, while the type specimen of *D. aduncus* fell between the two groups. The *T. truncatus* group contained large skulls, including the type specimens of *D. truncatus*, *T. australis* and *T. maugeanus*, as well as all *T. australis* specimens (Figs. 3.4 and 3.5).

Each of the first four PCs had Eigenvalues greater than 1 and were therefore useful in discriminating the components. These PCs accounted for 79.7% of the total variance, with PC1 alone accounting for 68.7% (Table 3.3). Width variables contributed most to the variance in PC1 and three height and one length variable also being important (Table 3.3). For PC2, only length variables had Eigenvalues greater than 0.7. Included in the above were variables (GPOW, ZW, UTLTR, RL, and CBL) that DFA also deemed important (Table 3.3).

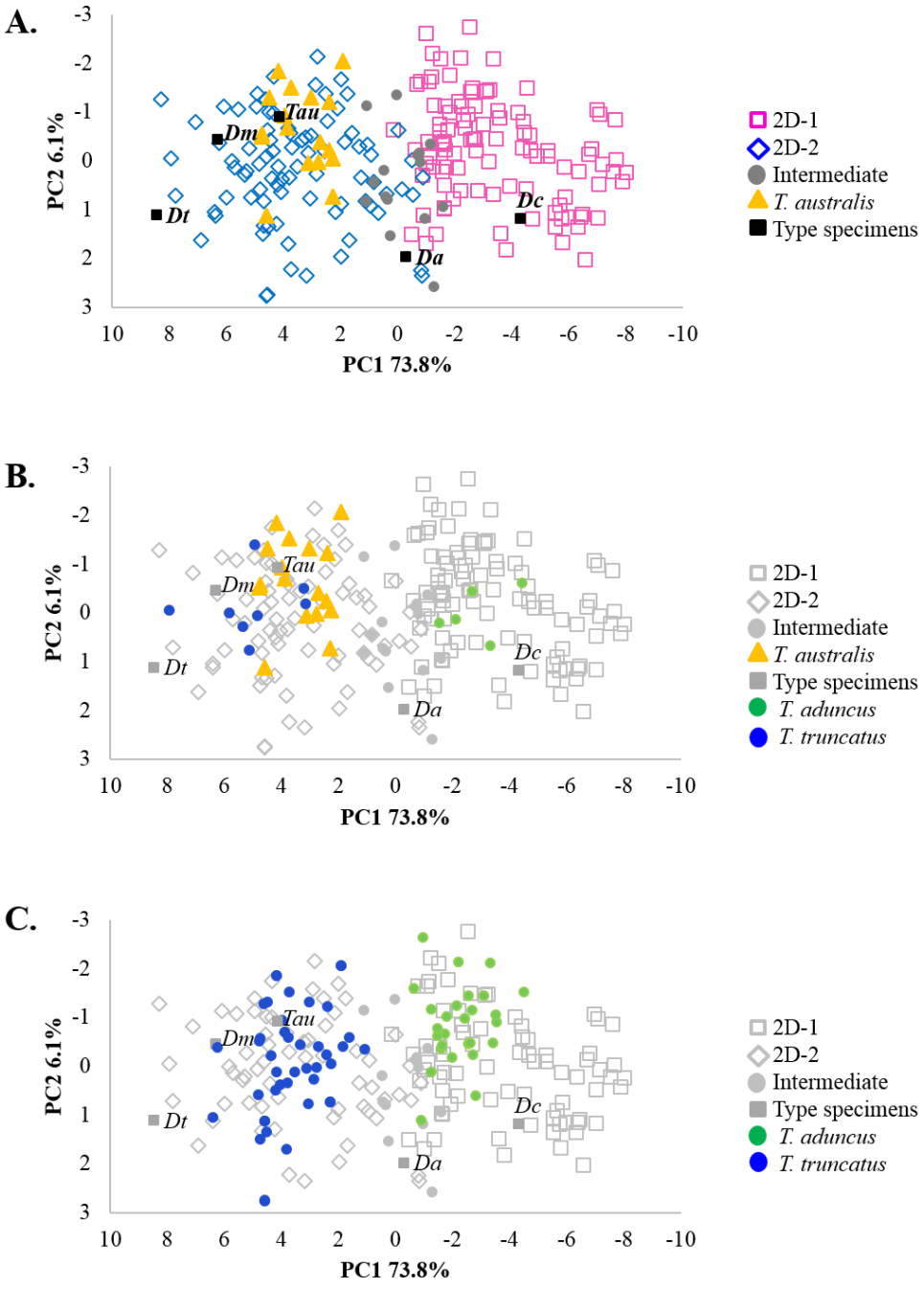

Figure 3.4. Principal component analysis (PC1 and PC2) of *Tursiops* spp. skull two-dimensional data. A) results from the present study, B) a visual comparison with species identification by Charlton-Robb et al. (2011), and C) a visual comparison to species identification by Kemper (2004). *Da* = *D. aduncus* holotype (BZM 66400), *Dt* = *D. truncatus* holotype (NHMUK 353a), *Tau* = *T. australis* paralectotype (QVM 1365), *Tm* = *T. maugeanus* junior synonym of *T. truncatus* (QVM 1360) and *Dc* = *D. catalania* syntype (NHMUK 1862.6.6.13).

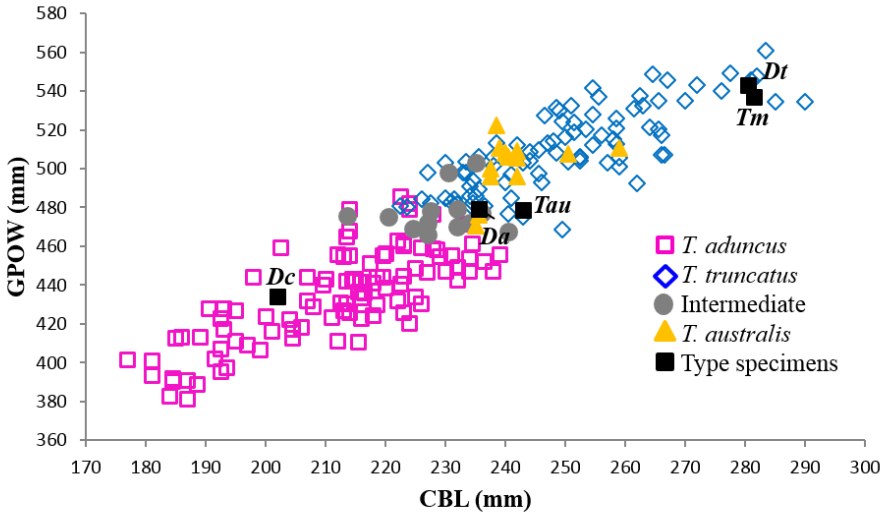

Figure 3.5. Plot of CBL against GPOW (see Supporting Table S3.1 for abbreviation definitions) showing size variation between *T. aduncus* and *T. truncatus* and two-dimensional intermediate groups. Group clustering based on results from HCA and DFA analyses. *Da* = *D. aduncus* holotype, *Dt* = *D. truncatus* holotype, *Tau* = *T. australis* paralectotyp, *Tm* = *T. maugeanus* junior synonym of *T. truncatus* and *Dc* = *D. catalania* syntype.

Table 3.3. *Tursiops* spp. two-dimensional variables with PCA loadings for the first four PCs (varimax rotation), and DFA results. Variables with Eigenvalues > 0.7 for one or more PCs, and DFA results > 0.5 shown in bold.

	Variable	PC1	PC2	PC3	PC4	DFA
Length						
CBL	condylobasal length	0.589	**0.724**	0.269	0.145	**-0.811**
RL	rostrum length	0.455	**0.817**	0.236	0.158	-0.133
TREN	tip of rostrum to external nares	0.470	**0.786**	0.241	0.147	0.320
ILB	internal length of braincase	**0.734**	0.421	0.300	0.121	0.088
TRPS	tip of rostrum to medial palatine suture	0.496	**0.786**	0.257	0.089	0.057
UTLTR	length of upper tooth row to tip of rostrum	0.452	**0.792**	0.218	0.135	**1.638**
ML	mandible length	0.577	**0.749**	0.247	0.120	**0.660**
LTRL	length of lower tooth row to tip of rostrum	0.454	**0.800**	0.206	0.127	-0.331
MSL	mandibular symphysis length	0.202	**0.744**	0.125	0.128	-0.009
Width						
RW60	rostrum width at 60 mm from base	**0.760**	0.507	0.221	0.183	-0.080
RW75%	rostrum width at 3/4 of rostrum length	**0.765**	0.416	0.162	0.159	0.234
RWM	rostrum width at mid-length	**0.780**	0.459	0.245	0.171	-0.171
RW25%	rostrum width at 1/4 of rostrum length	**0.754**	0.447	0.211	0.186	-0.041
PRW	premaxillae width at mid-rostral length	**0.756**	0.343	0.374	0.122	0.113
WRN	greatest width of right nasal	0.329	0.237	**0.738**	0.169	-0.066
WLN	greatest width of left nasal	0.244	0.211	**0.809**	0.141	-0.003
ZW	zygomatic width	**0.728**	0.479	0.186	0.415	**1.112**
GPOW	greatest postorbital width of skull	**0.760**	0.519	0.251	0.189	**-1.733**
GPARW	greatest width across parietals	**0.811**	0.182	0.330	0.127	0.013
GWPTF	greatest width of left temporal fossa	**0.746**	0.251	0.204	0.165	**0.553**
WAS	width of alisphenoid at suture with the basisphenoid	**0.738**	0.543	0.195	0.185	-0.095
Height						
HRN	greatest height of right nasal	**0.104**	0.054	0.207	0.849	-0.056
EHB	external height of braincase	**0.784**	0.444	0.326	0.154	0.232
EHBHP	external height of braincase to highest point	**0.765**	0.494	0.292	0.183	-0.061
MH	mandible height	**0.712**	0.549	0.288	0.093	0.660
PC Eigenvalue		29.32	1.82	1.47	1.18	-
Total variance		68.7%	4.7%	3.5%	2.8%	-
Cumulative variance		68.7%	73.4%	76.9%	79.7%	-

A DFA was carried out on three groups, representing *T. aduncus*, *T. truncatus* and *T. australis* (Fig. 3.4, Kemper 2004, Charlton-Robb et al. 2011), followed by MANOVA. The results showed support for *T. aduncus* and *T. truncatus* (DFA: Wilks $\lambda = 0.139$, $P < 0.001$, MANOVA: $F_{76, 268} = 1.205$, $P < 0.001$), while *T. australis* could not be distinguished from *T. truncatus* for any data used (original, log transformed or PC scores, $P > 0.05$).

Comparison of count and categorical data for *T. aduncus* and *T. truncatus* specimens resulted in statistically significant differences for some variables (Table 3.4). Compared with *T. truncatus* specimens, *T. aduncus* had more teeth in the lower tooth rows, smaller tooth diameter, more erosion to the pterygoids (possibly parasite-related), a lower , nuchal crest at the highest point of the skull, pterygoid and palatine of unequal length, flatter arch of the premaxilla, and fewer vertebrae. *Tursiops australis* specimens were not significantly different from *T. truncatus* for any of the count or categorical data, including those used by Charlton-Robb et al. (2011).

Table 3.4. Count and categorical variables showing significant differences between *T. aduncus* and *T. truncatus* specimens. Number, range and mean for *T. aduncus* and *T. truncatus* specimens, and F- or U value, degrees of freedom (df) and significance level (*P*) for the Student's *t*-test and Mann-Whitney U-test results. None statistically significantly categorical and count data (Supporting Table S3.4) included: temporal fossa shape, pterygoid hamular ridge shape, position of lower tip of pterygoid *vs.* top maxilla suture, pterygoid/maxilla suture, palatine shape, teeth upper left and right, and cervical vertebrae.

Variable	*T. aduncus*	*T. truncatus*	F/U, df, *P*-level
Counts			
Teeth lower left	101, 19–29, 24.32	83, 19–29, 23.68	2.66, 182, $P < 0.01$
Teeth lower right	98, 19–29, 24.18	82, 20–29, 23.63	2.20, 178, $P < 0.01$
Tooth diameter	86, 4.7–8.2, 5.79	73, 5.6–7.9, 6.70	11.05, 157, $P < 0.001$
Thoracic vertebrae	56, 11–13, 11.91	31, 12–13, 12.19	3.45, 85, $P < 0.001$
Lumbar vertebrae	56, 11–17, 14.75	29, 12–19, 16.00	3.93, 83, $P < 0.001$
Anterior caudal vertebrae	53, 15–20, 17.28	29, 17–21, 19.14	7.65, 80, $P < 0.001$
Posterior caudal vertebrae	45, 6–10, 8.36	22, 7–10, 8.86	2.39, 56, $P < 0.05$
Total vertebrae	42, 57–62, 59.28	16, 61–65, 63.00	7.82, 66, $P < 0.001$
Sequence number of first vertebra with perforating vertical foramen	55, 31–47, 39.38	29, 40–46, 44.31	8.30, 82, $P < 0.001$
Categorical			
Resorption to pterygoid	109, 1–4, 2	100, 1–4, 2	3145, $P < 0.001$
Extent of nuchal crest	118, 1–4, 2	115, 1–3, 2	4048, $P < 0.001$
Highest point of skull	119, 1–4, 2	114, 1–4, 2	4779, $P < 0.001$
Pterygoid and palatine length	109, 1–3, 1	100, 1–3, 1	4546, $P < 0.05$
Arch of premaxilla	119, 1–3, 1	115, 1–3, 1	5819, $P < 0.05$

Geometric morphometrics

Procrustes ANOVA (Table 3.5A and B) revealed a significant effect of directional asymmetry and size on the shape variance of the specimens. Conversely, no significant effect was found for sex. Therefore, the analyses below used only the asymmetric component of variation and combined females and males.

Table 3.5. *Tursiops* spp. three-dimensional geometric morphometric results of Procrustes ANOVA of A) size and shape data with sex, individuals and side as factors; B) Shape vs. the natural logarithm of centroid size. All analyses include 10,000 permutations. Sum of the squares (SS), mean squares (MS), degrees of freedom (df), F-value, significance level (*P*) and R squared (Rsq).

Effect	SS	MS	df	F	*P*	Rsq
A.						
Centroid size						
Sex	574.915	574.915	1	0.05	0.818	
Individual	1226035.420	10754.697	114			
Shape						
Sex	0.00197	0.0000179	110	0.89	0.794	
Individual	0.253	0.0000202	12540	9.23	< 0001	
Side	0.0308	0.000302	102	137.91	< 0001	
IndxSide	0.0257	0.00000219	11730			
B.						
Log (size)	0.08122	0.081216	1	37.243	< 0.01	0.15698
Residuals	0.43614	0.002181	200			0.84302
Total	0.51736		201			

Cluster analyses using Ward and UPGMA on PC of original shape data (Fig. 3.6A, Supporting Table S3.6) showed similar assignment when specimens fell into two groups (3DGM-1 and 3DGM-2). Group 3DGM-1 included type specimens of *D. aduncus* and *D. catalania*, while 3DGM-2 included type specimens of *D. truncatus*, *T. maugeanus* and *T. australis*, as well as other *T. australis*. PERMANOVA confirmed a statistical difference between the two groups ($F = 39.349$, $P < 0.001$, Table 3.6). A boxplot of centroid size between 3DGM-1 and 3DGM-2 showed the marked smaller size of the individuals in 3DGM-1 (Fig. 3.7) and the overlapping size of *T. australis* and other specimens in 3DGM-2. When 3DGM-1 and 3DGM-2 were themselves divided into two subgroups, these were significantly different from each other ($F = 26.46$, Bonferroni-corrected $P < 0.001$). However, the subgroup composition of these clusters varied slightly between Wards and UPGMA, where 18% ($n = 37$) of the specimens were assigned to different clusters. The subgroups showed some geographical separation, where one of the 3DGM-1 subgroups contained more samples from northern Australia, while the other one contained more samples from southern Australia. One of the 3DGM-2 subgroups contained *T. australis* specimens and other specimens from southern parts of Australia (Fig. 3.6A), while the other subgroup contained specimens from both the southern and northern parts.

Table 3.6. *Tursiops* spp. three-dimensional geometric morphometric results of PERANOVA (10,000 permutations) between group 3DGM-1 and 3DGM-2 of size-uncorrected and size-corrected shape with clustering as factor. Sum of the squares (SS), mean squares (MS), degrees of freedom (df), F-value, R squared (R2) and significance level (*P*).

Effect	SS	MS	Df	F	R2	*P*
Size-uncorrected						
Clustering (2 clusters)	0.07711	0.077109	1	39.349	0.1644	< 0.001
Residuals	0.39192	0.00196	200		0.8356	
Total	0.46903		201		1	
Size-corrected						
Clustering (2 clusters)	0.04088	0.040875	1	23.522	0.10523	< 0.001
Residuals	0.34755	0.001738	200		0.89477	
Total	0.38843		201		1	

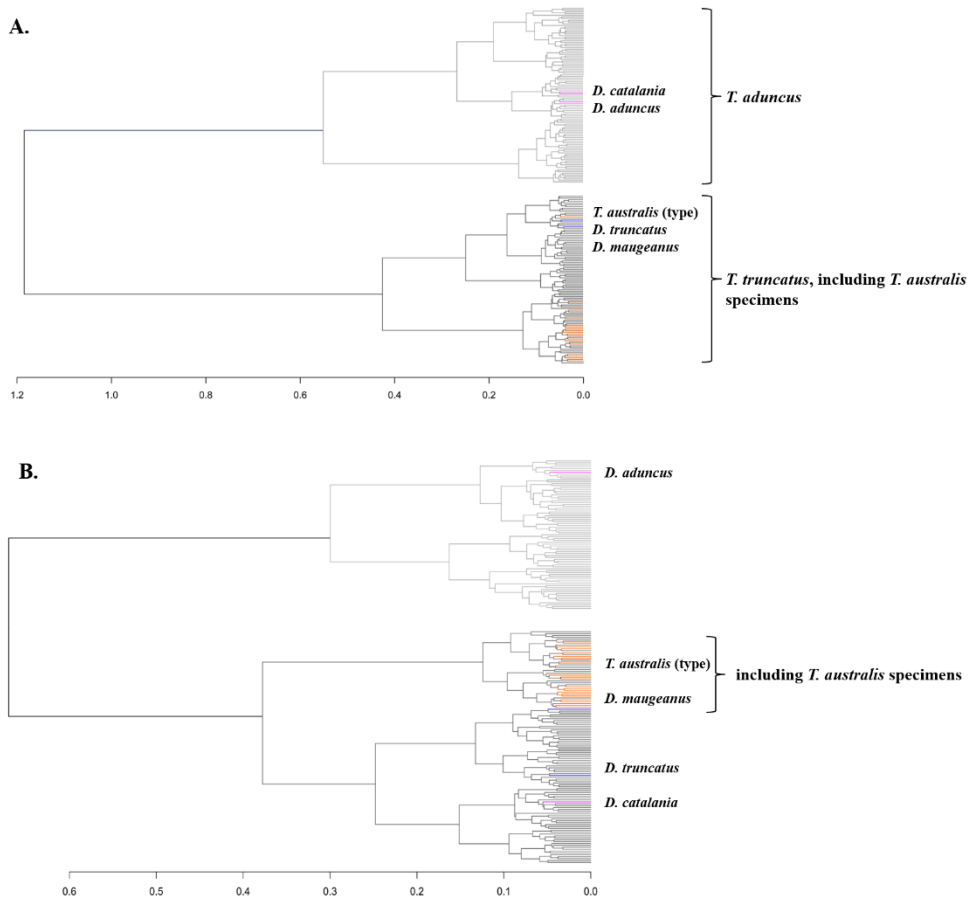

Figure 3.6. Hierarchical cluster analysis results for three-dimensional geometric morphometric, including all Australian *Tursiops* spp. and type specimens. 5(A) size-uncorrected shape data. 5(B) size-corrected shape data (all PCs except PC1). Different shades of grey distinguish the two main clusters. *Tursiops australis* specimens highlighted in orange.

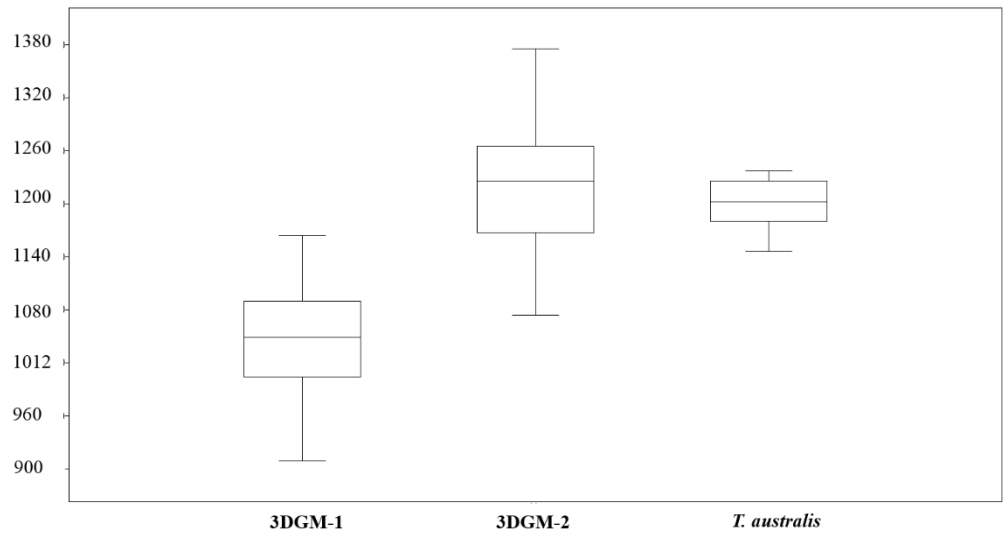

Figure 3.7. Boxplot of centroid size for Australian *Tursiops* spp. showing size variation between groups 3DGM-1, 3DGM-2 and *T. australis*. Group clustering based on results from HCA.

The second set of HCAs (on all the PCs of size-augmented shape data minus the first PC) also resulted in two groups for both Ward and UPGMA (Fig. 3.6B, Supporting Table S3.6) that were significantly different (PERMANOVA, $F = 23.522$, $P < 0.001$, Table 3.6). Of note is that group composition of these clusters was very different from that of the first set of HCAs on the original shape data. About half of the specimens ($n = 84$: 42% of the specimens) changed group assignment (Fig. 3.6A, Table 3.7), a result which is consistent with the importance of allometry in the shape variability of our specimens. *Tursiops australis* specimens fell within the same group as did the type specimens *D. truncatus*, *T. australis* and *T. maugeanus* for Ward but not for UPGMA. A counter-intuitive result for Ward was the position of *D. catalania* because it was associated with these latter type specimens rather than with *D. aduncus* as was the case for the first set of HCAs on the original shape data. When the two groups (3DGM-1 and 3DGM-2) were themselves divided into two subgroups, these were significantly different from each other ($F = 26.46$, Bonferroni-corrected $P < 0.001$). Some geographical trends could be found for specimens within the subgroups, where one of the subgroup contained mainly specimens from South Australia, the second subgroup contained many specimens from the northern coast, the third subgroup contained specimens from the southern coast including *T. australis*, and the fourth subgroups contained specimens from around Australia.

Table 3.7. *Tursiops* spp. specimens with discordant clustering groups for A = the two geometric morphometric cluster analyses (original coordinate configurations and shape data) and the two-dimensional results, and B = geometric morphometric clustering groups for the two-dimensional intermediate specimens. 1 = *T. aduncus* and 2 = *T. truncatus*.

ID	Sampling location	2D	3DGM (original)	3DGM (shape)
A.				
Percy Island	QLD	2	1	1
QMJM10114	QLD	1	2	1
M10852	NSW	1	2	1
M22971	NSW	2	1	2
M20878	SA	1	2	2
M19952	SA	1	2	2
M18048	SA	1	2	1
M24726	SA	2	1	2
M4794	WA	2	1	1
M7871	WA	2	1	1
25 of the specimens	All	2	2	1
50 of the specimens	All	1	1	2
T. catalania (type specimen)	QLD	1	1	2
B.				
M5723	WA	Intermediate	1	1
M7499	WA	Intermediate	1	1
M7584	WA	Intermediate	1	1
M15245	WA	Intermediate	1	1
M16298	WA	Intermediate	1	1
M25813	WA	Intermediate	1	1
M22838	NSW	Intermediate	1	2
Unregistered	TAS	Intermediate	1	2
C24990	VIC	Intermediate	2	2
M5902	SA	Intermediate	2	2
U0534	NT	Intermediate	2	2
JM7015	QLD	Intermediate	2	1

A PCA plot of the 3DGM results (on the original coordinate configurations) with specimens labelled according to the 2D species identification (Fig. 3.8, Table 3.7), showed that 3DGM-1 and 3DGM-2 appear to largely represent *T. aduncus* and *T. truncatus*. Only 10 specimens had different subgroup assignments, while almost half of the specimens fell into different groups when comparing 2D results to the second HCA (size-corrected data). This confirmed that the difference between the two groups including respectively *T. aduncus* and *T. truncatus*, was largely due to allometry, which are summarised by the distribution of the sample along the first PC of 2D data (correlation with size: 0.9). In addition, the 2D results showed more overlap in subgroups in the Ward analysis compared with UPGMA. Eight of the 2D intermediate specimens clustered with *T. aduncus* for the 3DGM and four with *T. truncatus* (Fig. 3.8, Table 3.7). Three-dimensional shape changes differentiating *T. aduncus* and *T. truncatus* included: a more rounded cranium in *T. aduncus* and a more angular cranium in *T. truncatus* (Fig. 3.9). The *T. aduncus* specimens had a longer and narrower rostrum than *T. truncatus*. Other differences were related to the supraoccipital, basioccipital, apex of the premaxillary convexity, external nares, temporal fossa, pterygoids, and lacrimojugal as shown in Fig. 3.9.

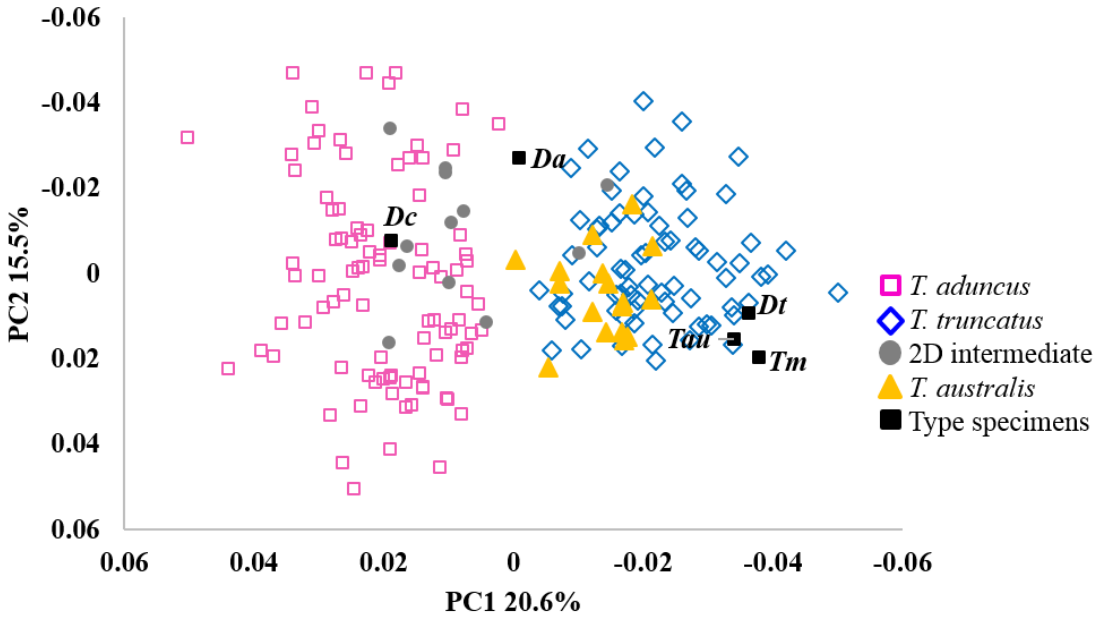

Figure 3.8. PC1 plotted against PC2 for three-dimensional geometric morphometric data including all *Tursiops* spp. Specimens labelled according to results of two-dimensional multivariate analysis. Hollow squares = *T. aduncus*, hollow diamonds = *T. truncatus*, circles = intermediate *Tursiops* spp., triangles = *T. australis*, *Da* = *D. aduncus* holotype (BZM 66400), *Dt* = *D. truncatus* holotype (NHMUK 353a), *Tau* = *T. australis* paralectotype (QVM 1365), *Tm* = *T. maugeanus* junior synonym of *T. truncatus* (QVM 1360) and *Dc* = *D. catalania* syntype (NHMUK 1862.6.6.13).

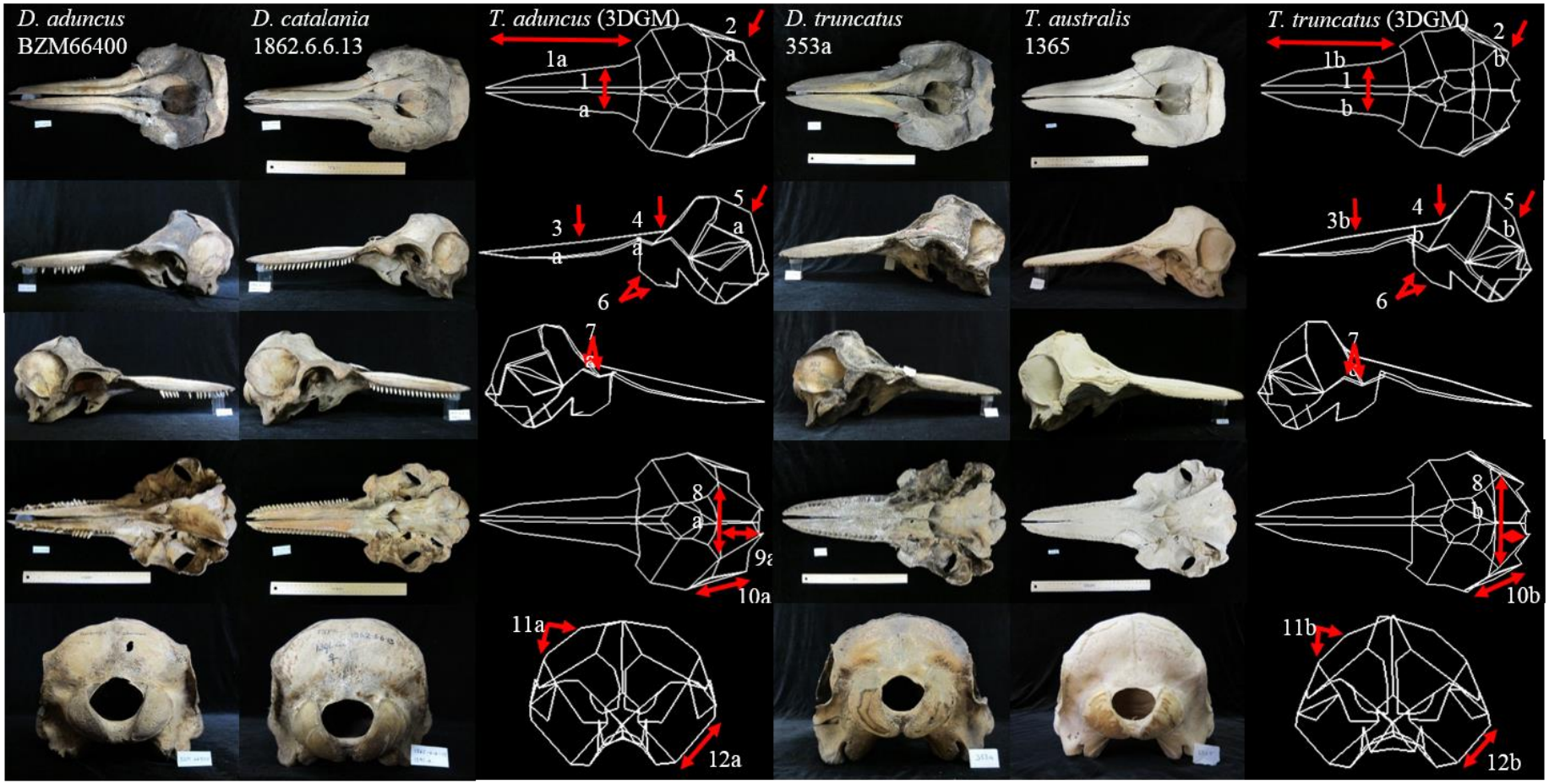

Figure 3.9. Dorsal, lateral, ventral and posterior views of *Tursiops* cranium for 3DGM *T. aduncus* and *T. truncatus* specimens along PC1 axis. Left: Example image of an extreme *T. aduncus*, and photos of holotype cranium *D. aduncus* (BZM66400), and syntype of *D. catalania* (1862.6.6.13). Right: Example image of an extreme *T. truncatus*, and photos of holotype cranium *D. truncatus* (353a), and type specimen of *T. australis* (1365). Posterior and ventral images show the PC1 angular vs. round shaped difference between *T. aduncus* and *T. truncatus* specimens. 1 = rostrum length and width, 2 = posterior flange of temporal fossa, 3 = apex of premaxillary convexity, 4 = position of external nares, 5 = supraoccipital shape, 6 = pterygoid shape and position, 7 = preorbital (lacrimojugal) position, 8 = width of alisphenoid at the suture with basisphenoid, 9 = distance between nuchal crest and occipital condyles, 10 = length of temporal fossa, 11 = nuchal crest shape, 12 = distance between landmark 34 (zygomatic width) and 73 (paraoccipital process) and 13 = basioccipital shape.

Geographical trends

With one exception, specimens from the Northern Territory aligned with *T. aduncus*, while those from Victoria and Tasmania aligned with *T. truncatus* (Fig. 3.10). The 2D intermediate specimens came from around the coast of Australia. Queensland, New South Wales, South Australia and Western Australia had specimens from both morphological groups. This trend was confirmed when latitude and CBL were compared for *T. aduncus* specimens (Fig. 3.11). There were no latitudinal trends for *T. truncatus* specimens.

Specimens were morphologically more different with increasing dyadic geographical distance using Procrustes data (*T. aduncus*: *r* Pearson = 0.390, 95% bootstrapped CI: 0.352−0.435, *P* permutation < 0.001; *T. truncauts*: *r* Pearson = 0.281, 95% bootstrapped CI: 0.243−0.316, *P* permutation < 0.001).

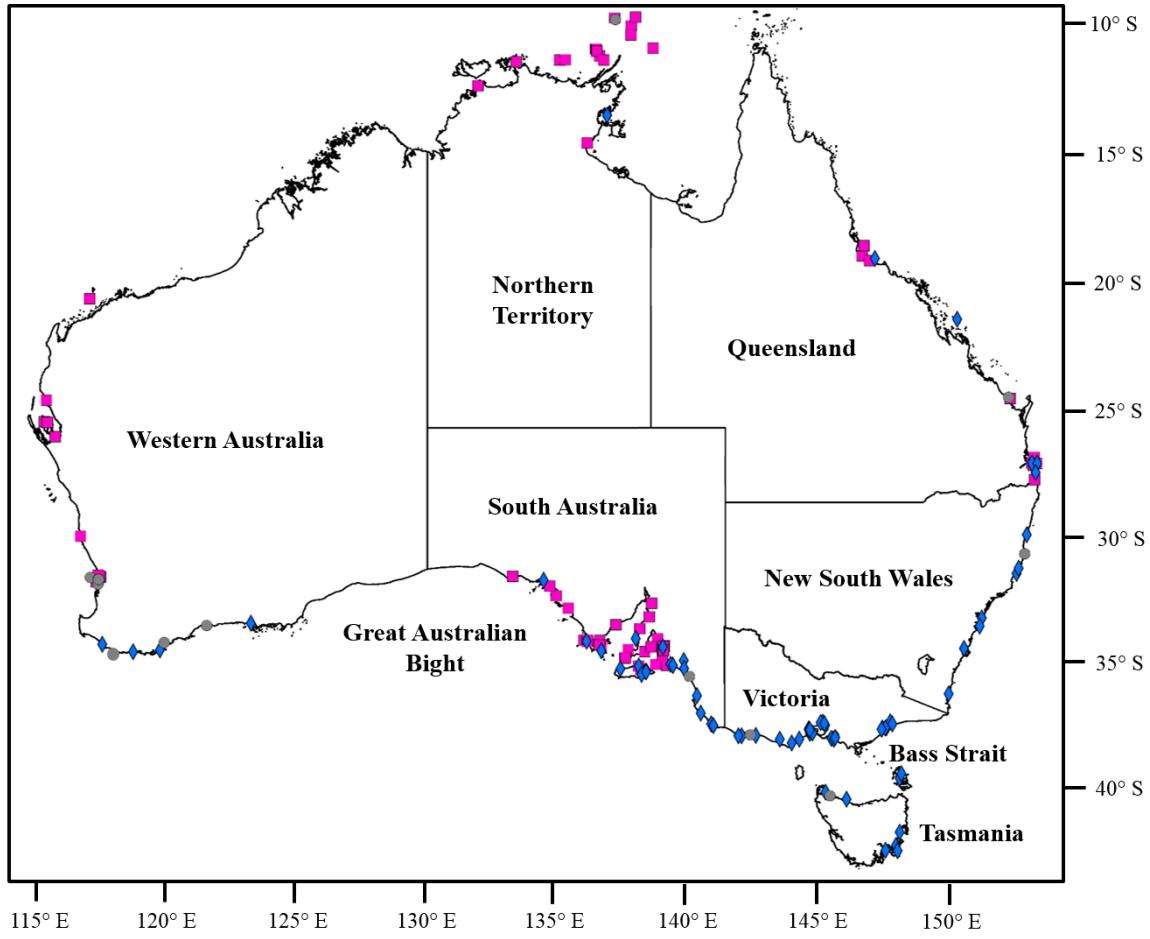

Figure 3.10. Geographic distribution of Australian *Tursiops* spp. Groups as determined by multivariate analyses. Squares = *T. aduncus*, diamonds = *T. truncatus*, and circles = intermediate.

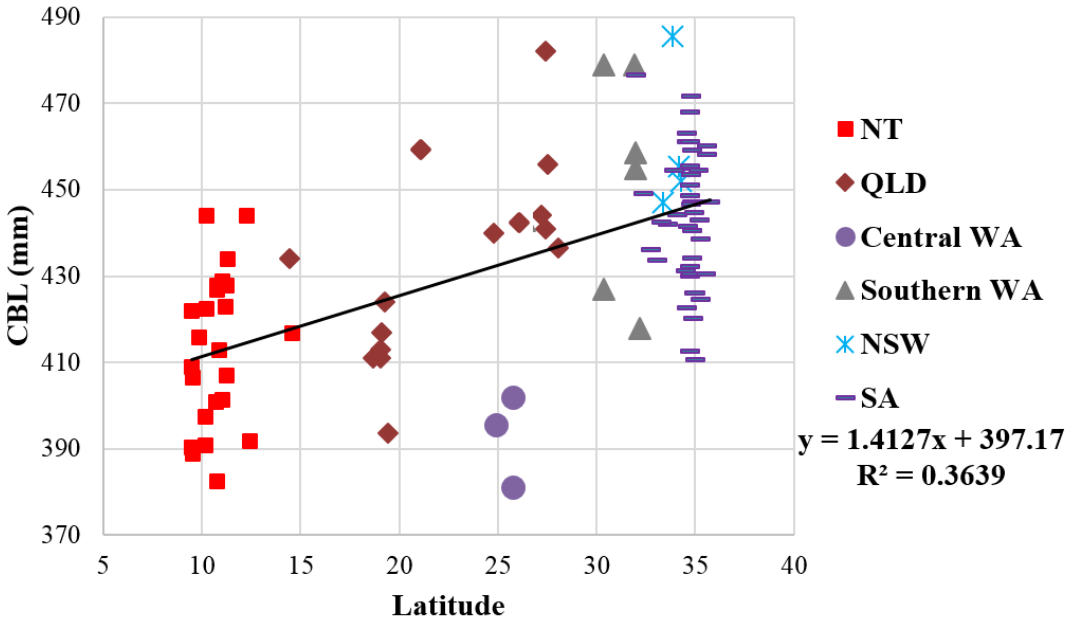

Figure 3.11. CBL plotted against latitude for *T. aduncus* specimens of known location, as determined by two-dimensional multivariate analyses. No *T. aduncus* specimens were available from Victoria or Tasmania.

3.5. Discussion

The results of the present study support for the presence of two species of bottlenose dolphin in Australia, *T. aduncus* and *T. truncatus*. The holotypes, for these species were larger than the Australian specimens and fell at the periphery of the 2D PC clusters. The Australian type specimens of *T. australis*, *T. maugeanus* and *D. catalania* aligned better with their respective species. Genetically, Australian bottlenose dolphins have been confirmed as *T. aduncus* and *T. truncatus* (Möller and Beheregaray 2001, Moura et al. 2013, Allen et al. 2016).

Charlton-Robb et al. (2011) found that *T. australis* could be distinguished from *T. aduncus* and *T. truncatus* using four diagnostic skull features and that its size was intermediate. Their study was based on few specimens from widely-spaced regions and they did not compare with morphological results for South Australian bottlenose dolphins (Kemper 2004). Intermediately-sized skulls were identified in the present study using 2D analyses, but they did not align with the *T. australis* specimens studied by Charlton-Robb et al. (2011). Overlap in skull size of *T. aduncus* and *T. truncatus* has previously been identified in South Australia (Kemper, 2004) and South Africa (Ross, 1977) but not Chinese waters (Wang et al. 2000*b*). The matter of intermediates is an interesting one and requires more study.

One of the strengths of the present study was the comparison of two-dimensional and three-dimensional methods for the same specimens. This enabled an examination of the effect of allometric patterns on shape variability. While size standardisation is also possible for 2D data (e.g. by dividing all measurements by the length of the skull), very few 3DGM studies have been published for *Tursiops* spp. When not controlling for size, 2D and 3DGM analyses showed many similarities in species composition. However, for size-corrected 3DGM results, *T. aduncus* and *T. truncatus* specimens were not separated into two distinct groups, which

suggests that shape differences are mostly due to size. *Tursiops australis* specimens aligned with *T. truncatus* for both 2D and 3DGM data if size was included or excluded from the analyses. It clustered in a subgroup together with other specimens from southern Australia for all 3DGM analyses.

Primary drivers for adaptation in cetaceans include feeding (Heyning and Mead 1996), sound production (Mead 2009) and swimming (Long et al. 1997). For example, rostrum shape and length and the number of teeth are related to prey size (Rice 1998, Rommel et al. 2009). In bottlenose dolphins (present study, Ross 1977, Wang et al. 2000*b*, Kurihara and Oda 2007), *T. aduncus* had a longer and narrower rostrum and more teeth than *T. truncatus*. This implies a difference in diet and habitat, which has been demonstrated in South Australian bottlenose dolphins (Gibbs et al. 2011). The arch of the premaxilla may also be linked to feeding mechanics (Rommel et al. 2009). Pterygoid shape, vertex position, nasal size, palatine and premaxillae length may be related to sound production in different environments (Mead 2009, Mead and Fordyce 2009). The number of vertebrae (present study; Ross 1977, 1984; Wang et al. 2000*b*), can be associated with manoeuvrability (Buchholtz and Schur 2004), which in turn may reflect environmental variability (Irschick and Garland 2001).

Bottlenose dolphin species can be both sympatric and parapatric (Hale et al. 2000, Wang et al. 2000*b*). *Tursiops aduncus* is generally associated with shallow water on the continental shelf, while *T. truncatus* is found in deep and shallow waters, both inshore and offshore (Rice 1998, Reeves et al. 2002). In several delphinid taxa, skull shape differs between inshore and offshore environments (de Araujo Monteiro-Filho et al. 2002, Jedensjö et al. 2017). In posterior view, inshore forms have crania with a rounded appearance, while those offshore are angular. This shape difference was obsered in Australian bottlenose dolphins and may be used to infer that *T. aduncus* is inshore and *T. truncatus* offshore. In addition, some forms of pterygoid erosion are caused by nematodes (Raga et al. 1982) that are more abundant in inshore habitats (Mead and Potter 1995). In the present study, *T. aduncus* had more pterygoid erosion than *T. truncatus*. A broad continental shelf is found off the northern coast of Australia, and almost all of the specimens from this region were assigned to *T. aduncus*. Most were by-caught in the offshore gillnet fishery up to 250 km from shore (Harwood and Hembree 1987). In South Australia, the large protected gulfs may act as drivers for the small size of *T. aduncus* there. In contrast, only *T. truncatus* was identified in the shallow waters of Bass Strait, an oceanographically unique habitat separating Tasmania from mainland Australia (Wilson and Allen 1987, Bunt 1987). Sea-level changes during the last two million years have resulted in both separation and connection of Tasmania and mainland Australia (Frakes et al. 1987), raising the possibility that *T. truncatus* arrived during a sea level rise.

Intraspecific morphological variation between widely-spaced populations (Perrin 1984, Perrin et al. 1999) is problematic for taxonomy. This is particularly relevant for *T. aduncus* because populations are likely to be centred on isolated land masses. Morphological comparisons of *T. aduncus* and *T. truncatus* from the same region have found distinguishing features and meristics. However, studies vary substantially in what features are being collected, in contrast to meristic data, and therefore difficult to compare between regions.

Comparison of meristic data from Australian bottlenose dolphins with those from China, Japan and South Africa (Table 3.8) showed that *T. aduncus* was similar, although much smaller. A similar pattern was observed for *T. truncatus* (Ross 1977, Wang et al. 2000*b*, Kurihara and Oda 2007), with those from Australia larger than conspecifics from China, but smaller than those from Japan and South Africa.

Some characters used in the present study were not effective in separating *T. aduncus* and *T. truncatus*. Future research needs to explore other characters. Genetic confirmation of species identity will assist this process, as will filling in distributional gaps and examining morphological differences within regions that may be driven by ecological factors.

Table 3.8. Comparison of osteological variables (min-max mm) of *Tursiops* spp. skull measurements between species found in Australia (present study, based on two-dimensional results), China (Wang et al. 2000*b*), Japan (Kurihara and Oda 2007), and South Africa (Ross 1977, 1984). Included are *T. australis* specimens (Charlton-Robb et al. 2011), and 13 intermediate specimens from two-dimensional multivariate analyses. Row below range for each variable shows total number, mean and standard deviation.

	T. aduncus				*T. truncatus*				*T. australis*	Intermediate
Variable	China	South Africa	Japan	Australia	China	South Africa	Japan	Australia	Victoria, Tasmania	Australia
CBL	451−529	433−507	480−501	381−486	394−561	504−578	477−554	469−561	471−523	466−503
	18, 485, 22	33, 473, 16	5, 492, 9	99, 434, 24	50, 506, 33	9, 546, 26	19, 513, 20	85, 510, 22	17, 501, 13	13, 477, 11
ML	386−461	373−422	404−429	312−421	341−481	426−498	395−489	401−475	405−449	393−419
	17, 415, 21	30, 400, 15	3, 416, 0.1	91, 366, 22	51, 434, 30	9, 466, 27	19, 441, 0.3	60, 440, 20	21, 427, 12	8, 402, 9
RL	258−317	250−297	273-300	212−282	204−320	283−335	255−317	260−315	264−297	256−290
	18, 282, 15	33, 272, 12	5, 288, 0.1	99, 242, 15	49, 284, 23	9, 309, 18	19, 284, 0.2	85, 289, 13	18, 278, 9	13, 270, 10
ZW	209−251	198−251	214−248	176−244	189−290	257−313	226−299	221−292	235−256	214−241
	13, 231, 14	30, 230, 11	5, 234, 0.2	98, 211, 15	50, 257, 21	9, 282, 20	19, 258, 0.4	84, 253, 17	21, 243, 5	13, 231, 7
MH	77−93	72−90	79−95	62−89	61−104	90−110	81−110	80−107	84−96	79−88
	17, 83, 4	30, 83, 4	3, 85, 0.1	91, 77, 6	51, 91, 8	9, 100, 6	19, 94, 0.2	60, 92, 5	21, 89, 3	8, 85, 3
RWM	56−71	56−75	60−73	45−73	55−102	73−106	71−105	61−101	70−84	63−76
	18, 64, 5	32, 65, 4	5, 68, 0.1	99, 61, 6	46, 84, 9	9, 89, 11	19, 86, 0.2	85, 80, 8	18, 79, 4	13, 68, 4
Teeth tot	96−111	97−111	N/A	82−114	80−106	88−96	N/A	81−109	93−115	96−108
	19, 102, 4	29, 103, 4	N/A	86, 98, 5	54, 94, 5	9, 93, 2	N/A	54, 97, 6	19, 101, 6	8, 101, 4
Vertebrae	59−62	59−62	N/A	57−62	64−67	64−65	N/A	61−65	63−64	58
	19, 60, 1	9, 61, 1	N/A	42, 59, 9	20, 66, 1	4, 65, 1	N/A	16, 63, 1	3, 63, 1	1, 58, N/A

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Chapter 4

Genetic structure of the genus *Tursiops* in Australian waters: Simple in the north and complex in the south

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Key words: *Tursiops*, genetics, mitochondrial DNA, autosomal markers, microsatellites, Y-chromosome, morphology, phylogeny

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Author contributions:
Maria Jedensjö conceived the study, conducted data collection from the museums, conducted statistical analyses, and wrote the manuscript.
Catherine M. Kemper and Michael Krützen conceived the study and edited the manuscript.
Sandra Gross conducted statistical analyses and edited the manuscript.
Simon J. Allen, Daniele Cagnazzi, Guido J. Parra, Lars Bejder and Carol Palmer conducted data collection and edited the manuscript.

4.1. Abstract

Tursiops spp. taxonomic history has been controversial and remains unresolved. We used 648 soft tissue and 210 bone and teeth samples, including type specimens, to investigate relationships among Australian *Tursiops* spp. Autosomal, mitochondrial DNA and Y-chromosomal markers compared on an individual level, found support for only two major clusters (*T. aduncus* and *T. truncatus*). Results were concordant for northern and eastern Australian individuals, but discordant for mtDNA for some western and southern coast individuals. Some individuals carrying mtDNA haplotypes that clustered with *T. truncatus* clustered with *T. aduncus* for autosomal and Y-chromosome markers, suggesting introgression and incomplete linage sorting for these locations. Our findings contradict prior studies supporting a third species, SABD/*Tursiops* cf. *australis*, in coastal South Australia, where our results showed extensive unidirectional mtDNA introgression from *T. australis* into *T. aduncus*. There appears some separation between *T. truncatus* and *T. australis* from southeastern Australia but no absolute divergence, as they could not be distinguished for autosomal and Y-chromosome markers, and clustered reciprocally monophyletically for mtDNA. This research illustrates the importance of including markers with different evolutionary histories for comparison with morphological results, and drawing comparisons on an individual level. Sound taxonomic conclusions over putative species should be drawn only from concordant findings among marker systems, and could be applied to delphinids worldwide.

4.2. Introduction

The formal identification of the boundaries between species is of importance in taxonomy, as well as in evolutionary and conservation biology (Guerra-García *et al.* 2008, Mace 2004, Samper 2004). In modern taxonomy, evolutionary relationships among taxa are defined by 'the sharing of derived character states to the exclusion of other taxa' (Perrin 2013), with identifying the boundaries between taxa being key (Petit and Excoffier 2009). However, species concepts have varied markedly between taxonomists (Helbig *et al.* 2002). Traditionally, morphological and anatomical features were used to resolve taxonomic uncertainties, but recent advancements in genetic and analytical methods have seen more frequent use in the last few decades (Allen *et al.* 2016, Chiari *et al.* 2009, Martien *et al.* 2014, Perrin 2013).

Mitochondrial DNA (mtDNA) has proven useful in phylogenetic studies (Hurst and Jiggins 2005), but reliance on a single marker has limitations and biases (Avise *et al.* 1987, Zhang and Hewitt 2003). The utility of mtDNA as a marker for evolutionary history has been questioned, for example, as it is insufficient for solving many taxonomic questions (Ballard and Whitlock 2004). Being transmitted to the offspring by the mother alone means inferences can be drawn only on matrilineal history, which could differ from that of the species as a whole (Avise *et al.* 1987, Moritz *et al.* 1987, Zhang and Hewitt 2003). Since females and males contribute different amounts of genetic information to the next generation (Greenwood 1980), Y-chromosomal markers, transmitted to the offspring by the father, are now increasingly being used and especially helpful in cases of male dispersal (Greminger 2016, Handley and Perrin 2007).

A combination of sex-specific and autosomal markers is advised when attempting to resolve taxonomic uncertainties, as these markers evolve under different evolutionary constraints (Lin and Danforth 2004). Taxonomic classification in the genus *Tursiops*, the bottlenose dolphin, within the family Delphinidae, represents one such challenge (LeDuc *et al.* 1999, McGowen 2011, Perrin 2013). Morphologically, the genus can be distinguished from other delphinids *Stenella, Delphinus, Steno, Lagenodelphis* and *Sousa* using 2D multivariate and 3D analyses on cranial data (Amaral *et al.* 2009, Jedensjö *et al.* 2017). However, depending on the marker system used, genetic studies of *Tursiops* support either monophyly (McGowen *et al.* 2009, Steeman *et al.* 2009) or polyphyly (Kingston *et al.* 2009, LeDuc *et al.* 1999, Xiong *et al.* 2009), most likely due to the relatively recent and rapid radiation of the group, leading to difficulties in resolving short branches produced by cladistic analyses, incomplete lineage sorting, and/or the difficulty of identifying clear diagnostic morphological characters (Amaral *et al.* 2009, Buchholtz and Schur 2004, McGowen 2011, Nikaido *et al.* 2007, Perrin 2013).

At least 20 *Tursiops* species have been named previously (Rice 1998), but only two are currently recognized worldwide; *T. truncatus* Montagu 1821, the common bottlenose dolphin, and *T. aduncus* Ehrenberg 1832, the Indo-Pacific bottlenose dolphin (Committee on Taxonomy 2018). Kinze (2018) concluded that *Tursiops tursio* (Gunnerus, 1768) predates *Tursiops truncatus*, but we will use the more universally adopted latter name. *Tursiops*

truncatus is found globally from the tropics to cold temperate waters in shallow waters over continental shelves to deeper waters further offshore, while *T. aduncus* is found in shallow waters around the coastlines of the Indian and western Pacific Oceans (Rice 1998; Reeves et al. 2002). Morphological studies have confirmed both species around Australia (Hale *et al.* 2000, Jedensjö *et al.* in review, Kemper 2004), while mtDNA results only have confirmed *T. aduncus* in northwestern and southeastern Australia (Allen *et al.* 2016, Möller and Beheregaray 2001, Moura *et al.* 2013), and *T. truncatus* in northwestern and southeastern Australia (Allen *et al.* 2016, Charlton-Robb *et al.* 2011, Möller *et al.* 2008).

A new *Tursiops* species was proposed for coastal southern and southeastern Australia (South Australia, Victoria and Tasmania) based on mtDNA and autosomal markers, the Southern Australian bottlenose dolphin (SABD hereafter, Bilgmann *et al.* 2007, Möller *et al.* 2008). In 2011, Charlton-Robb *et al.* (2011) named it a new species for southeastern Australia (Victoria and Tasmania, not including South Australia in their study), *T. australis* (the Burrunan dolphin), based on morphological analyses and mtDNA data. The SABD in South Australia and the southern coast of Western Australia was later assumed to be *T.* cf. *australis*, extending the geographical range of *T. australis* to along the southern coast of Australia (Gray *et al.* 2018, Moura *et al.* 2013, Pratt *et al*. 2018). However, SABD/ *T.* cf. *australis* in South Australia and further west has not yet been properly described, and therefore the species identification in this area still unclear (SABD for these samples from South Australia and further west hereafter). In addition, based on mitochondrial genomes, Moura *et al.* (2013) concluded 'an origin for the current *Tursiops* genus in coastal habitats in Australasia', with the SABD samples used in this study from South Australia being basal to all other *Tursiops*. Nevertheless, *T. australis* is not yet recognized by the Society for Marine Mammalogy's Committee on Taxonomy due to the small sample size in the original study, some overlap in metric characters, low support using molecular data, restricted geographical coverage for comparison within Australian waters, and the lack of comparison with *Tursiops* from other global regions and type specimens (Committee on Taxonomy 2018).

In this study, we integrate autosomal, mitochondrial and Y-chromosome markers to elucidate the genetic structure of the genus *Tursiops* in Australian waters, basing the study on the largest data set used to date, including extensive geographic coverage. Soft tissue, bone and teeth samples from both coastal and offshore locations were collected, including type specimens, to provide the first broad scale assessment of Australian *Tursiops* spp.

4.3. Material and Methods

Sample collection

We obtained 648 soft tissue samples and 210 bone and teeth samples of bottlenose dolphins, *Tursiops* spp., from both coastal and offshore locations around Australia (Supporting Fig. S4.1, Table 4.1, Supporting Table S4.2 and S4.3). For ease of geo-referencing, we report on sampling locations in this study by Australian states and coastal territory jurisdictions (Queensland, QLD; New South Wales, NSW; Victoria, VIC; Tasmania, TAS; South Australia, SA; Western Australia, WA; and Northern Territory, NT). We further subdivided the lengthiest coastline, WA, into three main sampling areas: northwestern, central and

southwestern (Supporting Fig. S4.1). For ease of referencing to previous studies, *T. australis* is hereafter referred to specimens from Victoria and Tasmania as defined by Charlton-Robb *et al.* (2011), and SABD for specimens from South Australia and further west (Bilgmann *et al.* 2007, Moura *et al.* 2013, Gray *et al.* 2018, Pratt *et al*. 2018) as the latter has not yet been properly described or confirmed to be *T. australis*.

Table 4.1. Number of soft tissues and bone/teeth samples of *Tursiops* spp. used in the study (n = 858), including type specimens, and collection state/location. Included is also number and sampling location of the soft tissue samples (88 of the 858 samples) used for the Y-chromosome amplification.

Sampling state/location	No of soft tissue samples	No of bone/teeth samples	No of samples used for the Y-chromosome
Queensland (QLD)	97	28	7
New South Wales (NSW)	19	28	7
Victoria (VIC)	19	26	8
Tasmania (TAS)	51	15	17
South Australia (SA)	88	23	8
Southern Western Australia (SWA)	59	-	8
Central Western Australia (CWA)	77	-	8
Northern Western Australia (NWA)	213	-	17
Western Australia (WA) bone/teeth	-	38	-
Northern Territory (NT)	25	46	8
Delphinus truncatus (holotype, *T. truncatus*), UK	-	1	-
Tursiops australis (paralectotype, *T. truncatus*), Tasmania	-	1	-
Tursiops maugeanus (junior synonym of *T. truncatus*), Tasmania	-	1	-
Delphinus catalania (syntype), Queensland	-	2	-
Red Sea	-	1	-
Total	648	210	88

To obtain soft tissue/biopsy samples from free-ranging dolphins, we used either a purpose-built remote darting system (Krützen *et al.* 2002) or biopsy pole (Bilgmann *et al.* 2007). We also included museum soft tissue samples collected from carcasses. Morphological data were available from most museum samples (Jedensjö *et al.* in review) for comparison with genetic results. Biopsy and soft tissue samples were preserved in a salt-saturated solution of 20 % dimethyl sulphoxide (Amos and Hoelzel 1991), in a saturated salt solution, in 96% v/v ethanol or frozen. Bone and teeth samples were collected from skulls held in nine Australian museums and the Natural History Museum, United Kingdom (Supporting Table S4.3) and stored dry. Bone samples were collected in 0.5 ml test tubes by drilling into the cranium for bone shavings, and teeth were pulverized. Included were bone and teeth samples of the holotype of *T. truncatus* (*Delphinus truncatus* Montagu, 1821), and four Australian type specimens: two syntypes of *D. catalania*, Gray 1862 and two syntypes of *T. maugeanus* Iredale and Troughton 1934 (Table 4.1, Supporting Table S4.3). It is worth noting that the male *T. maugeanus* became a junior synonym of *T. truncatus*, while the female became a paralectotype (Charlton-Robb *et al.* 2011).

DNA extractions and molecular sexing

We extracted DNA from soft tissue samples using the Gentra Puregene Tissue kit (QIAGEN), and from teeth and bone samples, using the EZ1 DNA Investigator Kit (Large-Volume Protocol, QIAGEN). Manufacturer's instructions were followed for both protocols. The extracted genomic DNA was re-suspended in TE buffer (10 mM Tris, 1 mM EDTA, pH 8) and the concentration adjusted to 20 ng/µL. Individuals for which we had soft tissue samples were genetically sexed using primers that anneal to the ZFX and SRY genes (Gilson *et al.* 1998, details in Supporting Information S4.4).

Autosomal genotyping

We genotyped the soft tissue samples for 19 microsatellite loci: seven of these markers being dinucleotide markers; D22 (Shinohara *et al.* 1997), MK3, MK5, MK6, MK8, MK9 (Krützen *et al.* 2001), KWM12 (Hoelzel *et al.* 1998); and 12 were tetranucleotides; Tur4_66, Tur4_80, Tur4_98, Tur4 105, Tur4_108, Tur4_111, Tur4_117, Tur4_128, Tur4_132, Tur4_142, Tur4_153 and Tur4_162, using the protocols in Nater *et al.* (2009). After 20x dilution of PCR products with ddH2O, we mixed 1 µl of the diluted product with 9.95 µl HiDi formamide, and 0.07 µl GeneScan 500 LIZ size standard (both Applied Biosystems). After denaturation at 95°C/3 min, PCR products were run on a 3730 DNA analyzer (Applied Biosystems). Lengths of fragments were determined with GENEMAPPER (Applied Biosystems).

Mitochondrial DNA genotyping

We amplified and sequenced 474 base pairs (bp) of the hypervariable region or the mitochondrial control region (HVR-1) using primers dlp1.5 and dlp5 (Baker *et al.* 1993, Pichler *et al.* 1998). PCR products were cleaned using silica membrane spin columns (GeneEluteTM by Sigma-Aldrich). Using the Cycle Sequencing Ready Reaction kit (BigDye Terminator v3.1 – Applied Biosystems), we sequenced the PCR products based on the protocol described in Bacher *et al.* (2010), using sequencing primer dlp 1.5. We used SEQUENCING ANALYSIS v5.2, BIOEDIT v7.0.5.3 (Hall 1999), and LASERGENE V8 software (DNASTAR) to visually quality control, edit and align the sequences (Supporting Information S4.4).

Y-chromosomal genotyping

Using soft tissue samples, we amplified four Y-chromosomal anchor-tagged sequence (Y-CATS) loci DBY7, DBY9, SMC7and UTY11 (Hellborg and Ellegren 2003) for a geographically representative sub-sample (n = 88, Table 4.1). The PCR product was cleaned up after the cycle sequencing by adding 75µl of an $MgSO_4$ solution (70% Ethanol, 0.2 mM $MgSO_4$), and sequenced PCR products as described for mtDNA. This was followed by use of SEQUENCING ANALYSIS v5.2, BIOEDIT v7.0.5.3 (Hall 1999), and LASERGENE V8 software (DNASTAR) to visually quality control, edit and align the sequences (Supporting Information S4.4).

Statistical methods

Autosomal markers — For any two samples with 98% or more similarity based on microsatellite identity, one duplicate sample was randomly removed. We tested for deviations

from Hardy-Weinberg Equilibrium (HWE) expectations and occurrences of linkage disequilibrium (LD) within each sampling location using the Fisher exact test as implemented in GENEPOP v.4 (Raymond and Rousset 1995, Rousset 2008), and screened for potential scoring errors. Significance levels were adjusted for multiple comparisons using Bonferroni correction (Rice 1989).

A Bayesian model-based clustering method implemented in STRUCTURE 2.3.3 (Pritchard *et al.* 2000) was used to test for population genetic structure and to assign individuals to populations. We carried out a hierarchical analysis, first including all samples. We then ran a second, independent analysis for each of the two major clusters that had been identified during the first run (see Results). All STRUCTURE runs were performed without specifying population origin or sampling location, using a population admixture model. Running parameters had a burn-in period of 100,000 iterations followed by 1,000,000 Markov Chain Monte Carlo (MCMC) iterations. The number of clusters (K) was set to values of 1−15 for each of 10 independent runs. The most likely number of clusters (K) was determined estimating the mean maximum loglikelihood of the data (LnP (D), Pritchard *et al.* 2000) by calculating ΔK with respect to K (Evanno *et al.* 2005) using STRUCTURE HARVESTER (Earl 2012).

Two different measures of differentiation between populations identified within each major cluster were examined using the fixation index F_{ST} (ARLEQUIN, v 3.5.1.2, Excoffier and Lischer 2010) and R_{ST} (GENEPOP v.4.0). In order to estimate differentiation of sampling sites within each major cluster, samples were subdivided into sampling locations according to their geographical distribution. Samples collected within 50 km (direct Euclidian distance) of each other, and not more than 10 years apart were grouped. Based on these criteria, we grouped samples from the first and second major cluster identified in STRUCTURE into 23 (Supporting Table S4.5) and 12 sampling locations (Supporting Table S4.6), respectively.

Mitochondrial DNA markers — We inferred phylogenetic relationships among samples using a Bayesian approach as implemented in MRBAYES v3.2 (Huelsenbeck and Ronquist 2001, Ronquist and Huelsenbeck 2003). The most appropriate substitution model was determined in JMODELTEST, V2.1 (Darriba *et al.* 2012, Guindon and Gascuel 2003). We used the generalized time reversible model, with equal gamma-distributed rate variation across sites and a proportion of invariable sites. We ran two MCMCs for 10,000,000 iterations, with a sampling frequency of 500, and a burn-in run of 20,000 data points. Consensus trees were displayed using FIGTREE v1.4.0 (http://tree.bio.ed.ac.uk/software/figtree/). The HVR-1 sequence of the holotype of *T. aduncus* (*Delphinus aduncus*, Ehrenberg 1832) was downloaded from Genebank (#DQ517442). We used a sequence of *Orcaella heinsohni* as an out-group for all analyses.

Genetic differentiation between sampling locations (as defined above) was assessed by calculating Φ_{ST} (ARLEQUIN, v 3.5.1.2), with 1,000 permutations for comparison to test for significance.

Y-chromosomal markers — Given the uniparental clonal inheritance of the Y-chromosome, the four Y-chromosomal loci used in the study are completely linked (Charlesworth and Charlesworth 2000). Thus, we concatenated all four loci and analysed them as a single sequence. The nucleotide substitution model that best fitted the data was the Hasegawa-Kishino-Yano (HKY) model, as estimated with JMODELTEST v2.1. We inferred phylogenetic relationships among Y-chromosomal sequences using a Bayesian approach, as implemented in MRBAYES v3.2. We ran two MCMCs for 10,000,000 iterations with a sampling frequency of 500, burn-in run of 2,500 data points. Consensus trees were displayed using FIGTREE v1.4.0. We used a sequence of *Delphinus delphis* as an out-group for all analyses.

Bathymetric features and genetic clusters

To identify a possible link between bathymetry and genetic structure, we compared average water depth for each of the two major clusters of *Tursiops* samples identified in STRUCTURE. For samples with GPS locations, we extracted depth information (Geoscience Australia 2009) for each individual using ArcGIS (v. 10.1), and used a student's *t*-test in SPSS to test for differences in water depth between the two STRUCTURE clusters (v. 22.0 Armonk, NY: IBM Corp.). The *T. australis* and SABD samples in this study were collected from stranded animals, which may not be representative of normal home range due to potential drift at sea (Peltier *et al.* 2012) and were thus, not included in this analysis.

4.4. Results

Autosomal data

We obtained autosomal data for 550 soft tissue samples, which fell into the most likely number of clusters *K*=2. These two major clusters did not have clear geographical separation (Fig. 4.1A), but appeared to largely represent *T. aduncus* and *T. truncatus*. Species identification was based on previous species identification of samples from northwestern WA (Allen *et al.* 2016), which all were assigned to the same species as our results. At higher *K*s, additional groups appeared in both the two major *T. aduncus* and *T. truncatus* clusters. At *K*=3, a separate group was emerged in *T. aduncus* from the east coast (QLD and NSW, Fig. 4.1B). At *K*=4, samples from the southeastern parts of the Australian coast (VIC, TAS and SA) formed an additional separate group (Fig. 4.1C). These samples (Supporting Table S4.7 and Table 4.2) fell into the *T. truncatus* cluster for *K*=2 and had previously been morphologically and genetically identified as *T. australis* from Victoria and Tasmania (Charlton-Robb *et al.* 2011, Charlton *et al.* 2006). At *K*=5, *Tursiops aduncus* samples from SA emerged as an additional group (Fig. 4.1D).

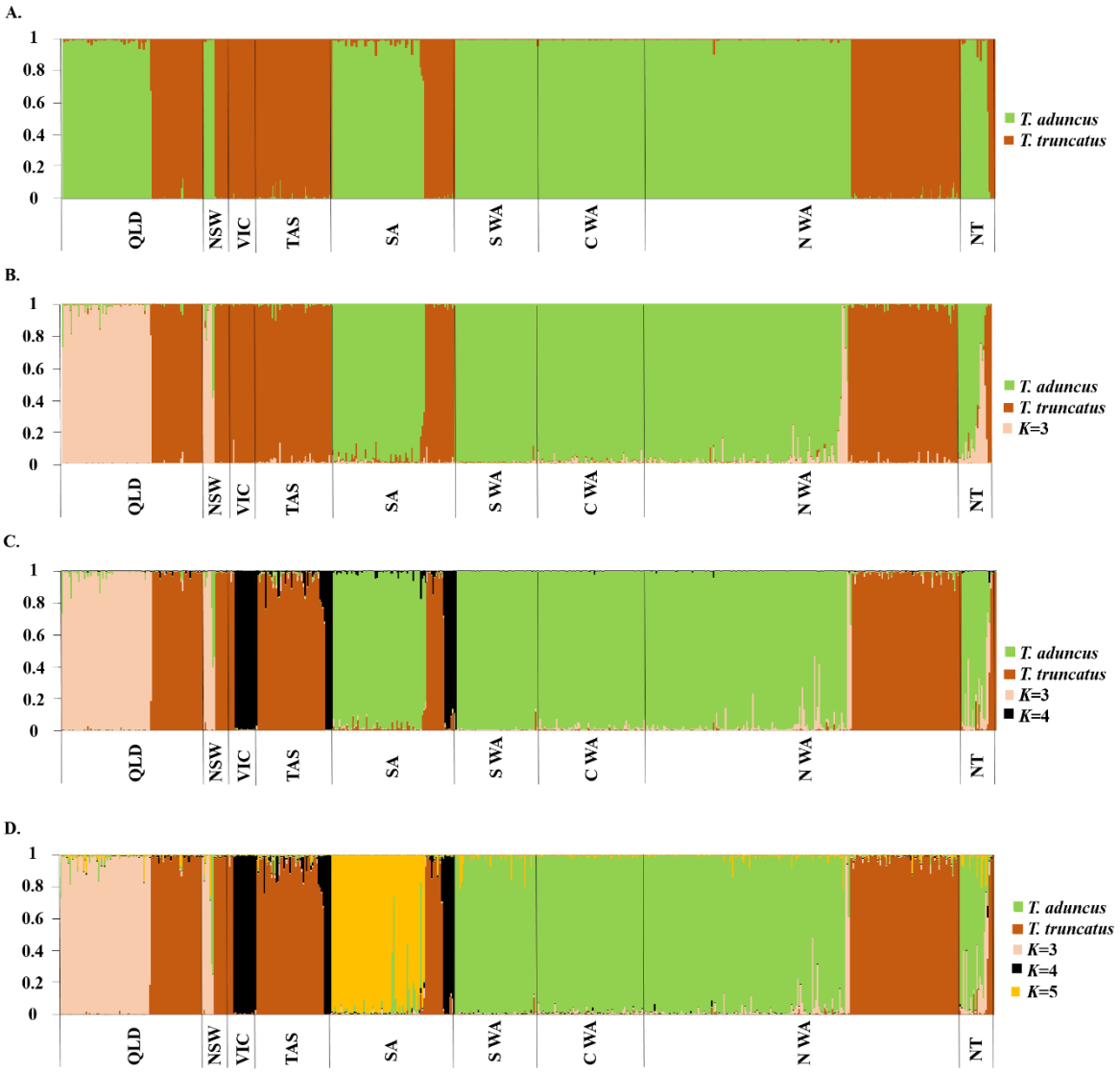

Figure 4.1. Bayesian clustering from STRUCTURE based on 19 autosomal loci from all *Tursiops* spp. soft tissues. Each individual is represented by a vertical column, with the color indicating the relative estimated group membership. A) *K*=2, green = *T. aduncus*, and brown = *T. truncatus*. B) *K*=3. C) *K*=4. D) *K*=5. QLD = Queensland, NSW = New South Wales, VIC = Victoria, TAS = Tasmania, SA = South Australia, SWA = southern Western Australia, CWA = central Western Australia, NWA = northern Western Australia, and NT = Northern Territory.

Table 4.2. Allocation of individuals to recognized species based on three different marker systems. Autosomal allocations are based on the 'global' Structure analyses for *K*=2 and *K*=4 (Fig. 4.1). Colors in table entries represent those in Fig. 4.1. For mtDNA and Y-chromosomal markers, allocations in subgroups was based on Bayesian inferences (Figs. 4.5 and 4.6). Leftmost color in mtDNA and Y-chromosomal cells represents allocation based on *K*=2. Species identification of *T. aduncus* and *T. truncatus* based on (Allen *et al.* 2016, Kemper 2004, Jedensjö *et al.* in review), *T. australis* based on (Charlton-Robb *et al.* 2011), and southern Australian bottlenose dolphin (SABD) in South Australia and southern Western Australia based on (Bilgmann *et al.* 2007, Pratt *et al.* 2018). Sampling locations: CWA = central Western Australia, SWA = southern Western Australia, SA = South Australia, TAS = Tasmania and VIC = Victoria (see Table 4.1 and Fig. 4.1).

Allocation to genetic grouping based on three different marker systems	**Autosomal 'Global' STRUCTURE Analysis (*K*=2)**	**Autosomal 'Global' STRUCTURE Analysis (*K*=4)**	**Mitochondrial DNA**	**Y-chromosomal**
Group I, *T. aduncus* Eastern Australia: N of 35°S Western Australia: N of 24°S	*T. aduncus*	*T. aduncus*	*T. aduncus* subgroup A and B	*T. aduncus* subgroup A
		T. aduncus	*T. aduncus* subgroup A	
Group II, *T. aduncus* Western Australia: sampling location CWA	*T. aduncus*	*T. aduncus*	*T. aduncus* subgroup A	*T. aduncus* subgroup A
			T. truncatus (2 haplotypes) subgroup A	
Group III, *T. aduncus* Western Australia: sampling location SWA	*T. aduncus*	*T. aduncus*	*T. aduncus* subgroup A	*T. aduncus* subgroup B
			T. truncatus (2 haplotypes) subgroup A	
Group IV, *T. aduncus* and SABD southern Australia: sampling locations VIC, TAS, SA	*T. aduncus*	*T. aduncus*	*T. truncatus* subgroup B	*T. aduncus* subgroup B
Group V, *T. truncatus* All sampling locations: QLD/NSW, VIC, TAS, SA, NWA/NT	*T. truncatus*	*T. truncatus*	*T. truncatus* subgroup A and a few B	*T. truncatus*
Group VI, *T. australis* southern Australia: sampling locations SA, TAS, VIC	*T. truncatus*	***T. australis***	*T. truncatus* subgroup B	*T. truncatus*

Individuals assigned to *T. truncatus* at *K*=2 in the global analysis were sampled at an average water depth of 72 m (range = 1-188 m, SD = 38 m), significantly deeper than *T. aduncus*, which were sampled in average depths of 12 m (range = 1-75 m, SD = 19, student's $t = 19.92_{356}$, $P < 0.001$, Fig. 4.2).

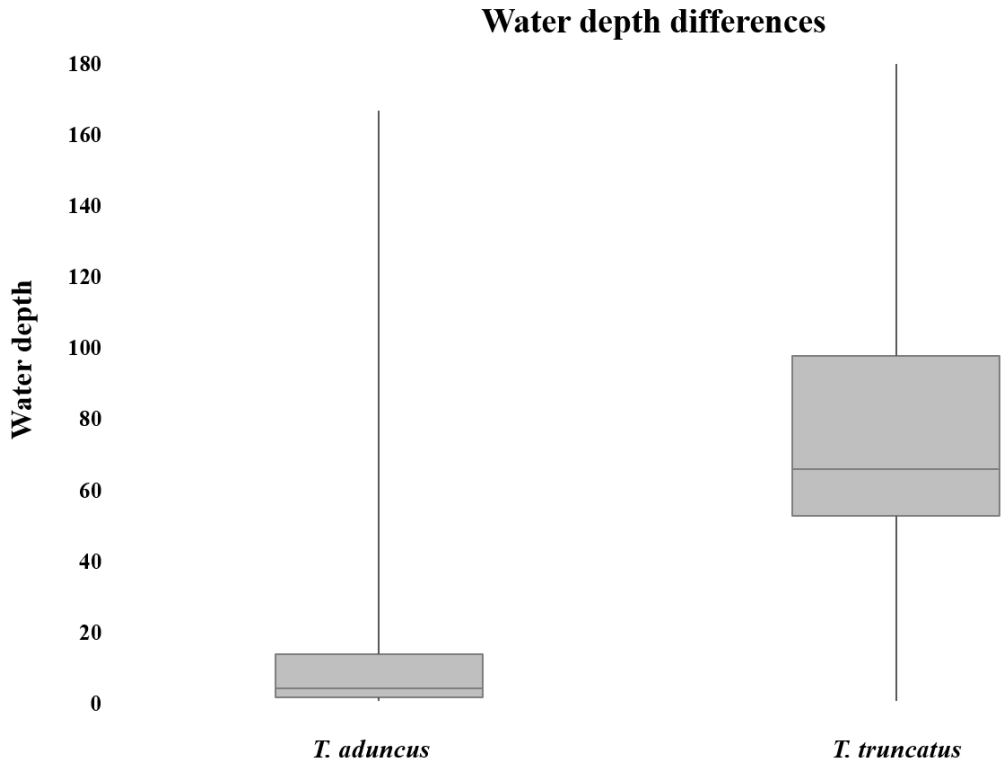

Figure 4.2. Box plot of water depth for all *Tursiops* biopsy samples included in the study from Queensland, New South Wales, south Western Australia, central Western Australia, north Western Australia and Northern Territory. The plot is based on results from STRUCTURE, at the most likely number of groups, *K*=2. Median (the line dividing the box into two parts) = marks the mid-point for the data, and the vertical line = the data range.

Pairwise comparisons, based on F_{ST}, and R_{ST} between all sampling locations of *T. truncatus* and *T. aduncus*, exhibited significant differentiation between most sampling locations on the west, north and east coast (Supporting Tables S4.5 and S4.6). Some sampling locations in close geographic proximity, however, lacked such differentiation. We found a similar pattern in southern Australian waters for most sampling locations, although some were genetically similar despite geographical distance between populations.

Tursiops aduncus individuals were found in all sampling locations except the southeastern coast (VIC and TAS). When the *T. aduncus* cluster was considered separately in a STRUCTURE analysis (Fig. 4.3), the most likely number of clusters was *K*=6. At this level, most genetic groups occurred well within geographic boundaries (Fig. 4.3A).

Tursiops truncatus individuals were found in almost all sampling locations (QLD, NSW, VIC, TAS, SA, northern WA and NT) except southern and central WA, where samples were only collected from near-coastal waters. The STRUCTURE analysis for *T. truncatus* individuals

only, revealed five (*K*=5) genetic clusters. Three of these clusters occurred along the southern Australian coast (Fig. 4.3B) and revealed extensive geographical overlap (Fig. 4.4), one of which contained samples previously morphologically and genetically identified as *T. australis* (Charlton-Robb *et al.* 2011, Charlton *et al.* 2006). The other two clusters, confined to the eastern (QLD and NSW) and northwestern (northern WA) part of the coast, showed clear spatial separation.

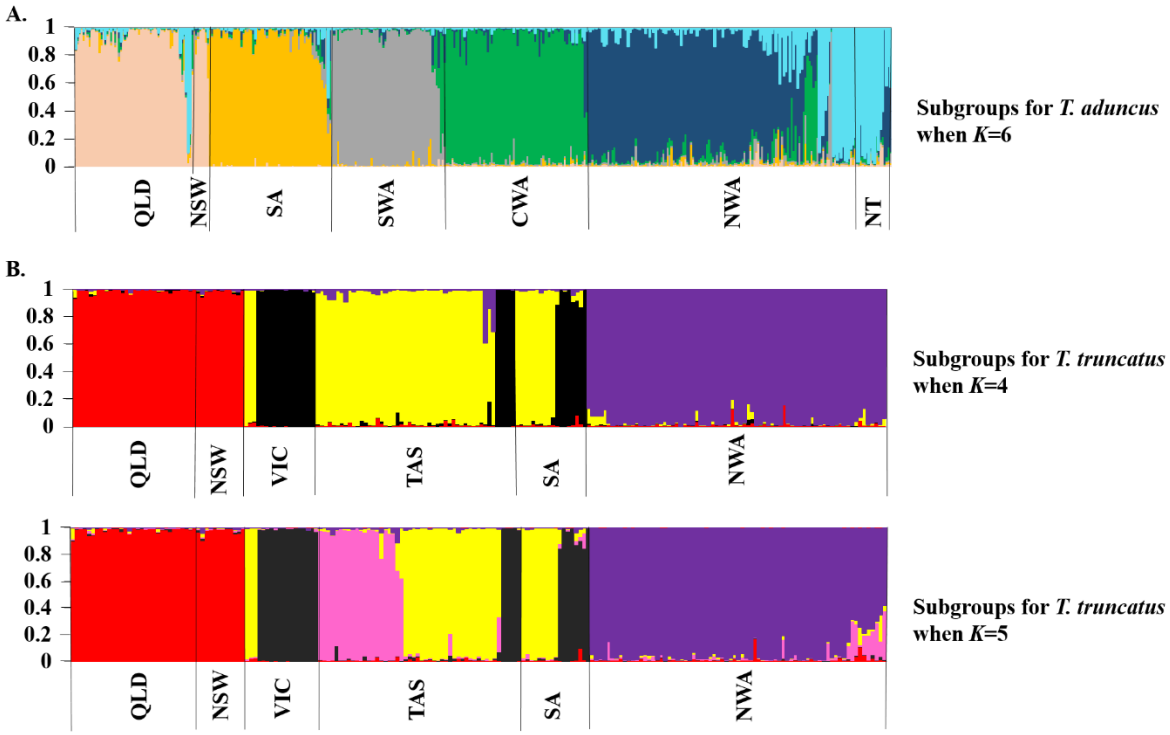

Figure 4.3. Bayesian clustering from STRUCTURE, for each subgroup independently, based on 19 autosomal loci from all *Tursiops* spp. soft tissues. Each individual is represented by a vertical column, with the color indicating the relative estimated group membership. A) *T. aduncus* at *K=6* and, B) *T. truncatus* at *K=4–5*. For abbreviations of sampling location see Fig. 4.1.

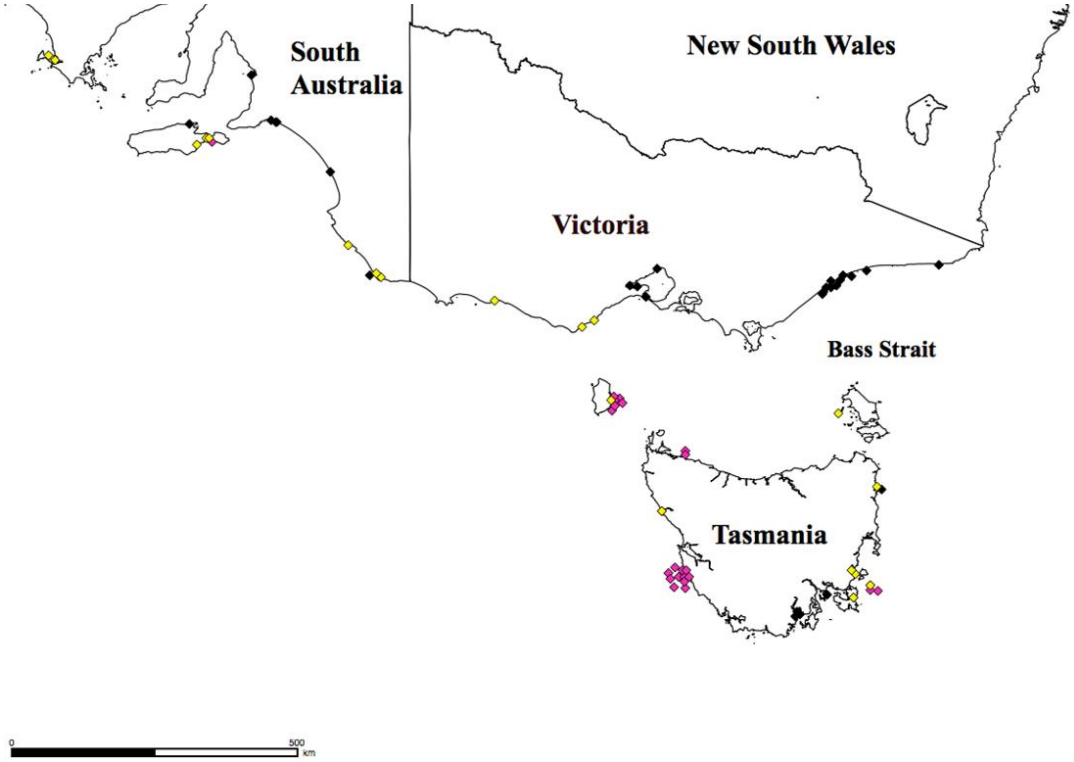

Figure 4.4. Geographical location of *Tursiops truncatus* samples from Victoria, Tasmania and South Australia with color code showing tree genetic clusters out of the five found by STRUCTURE (Fig. 4.3), indicating the overlap of the geographical overlap of the three groups in this region.

Mitochondrial DNA data

We obtained HVR-I data for 648 soft tissues samples and 135 bone/teeth samples (including type specimens) and identified 150 unique haplotypes with a total of 109 segregating sites (Supporting Table S4.8). Our phylogenetic reconstruction revealed two major clades (Fig. 4.5). These two major clades represented *T. aduncus* and *T. truncatus*, by comparison with Allen *et al.* (2016) and Kemper 2004. All *T. australis* samples were embedded within the *T. truncatus* clade. However, they clustered in a subgroup which was reciprocally monophyletic to the other *T. truncatus* samples, although bootstrap support was low (Fig. 4.5).

The first major clade for mtDNA, comprising of *T. aduncus*, was highly supported (Fig. 4.5). Within this clade, there were two major subclades with strong geographic components: individuals from the east coast of Australia formed one major subclade; and those from the north and west coast of Australia formed the other clade. Interestingly, none of the samples from SA clustered in the mtDNA *T. aduncus* clade, although *T. aduncus* previously has been identified morphologically from there (Jedensjö *et al.* in review, Kemper 2004).

The second major clade for mtDNA, comprising of *T. truncatus* and *T. australis*, was moderately supported (Fig. 4.5). Within this clade, there were two reciprocally monophyletic major subclades, both having, to some extent, geographic components. One major subclade contained samples obtained in waters off all Australian states and territories, without geographic structure, while the second major subclade contained samples only from southern Australian waters (VIC, TAS, and most samples from SA), including samples previously identified as *T. australis*.

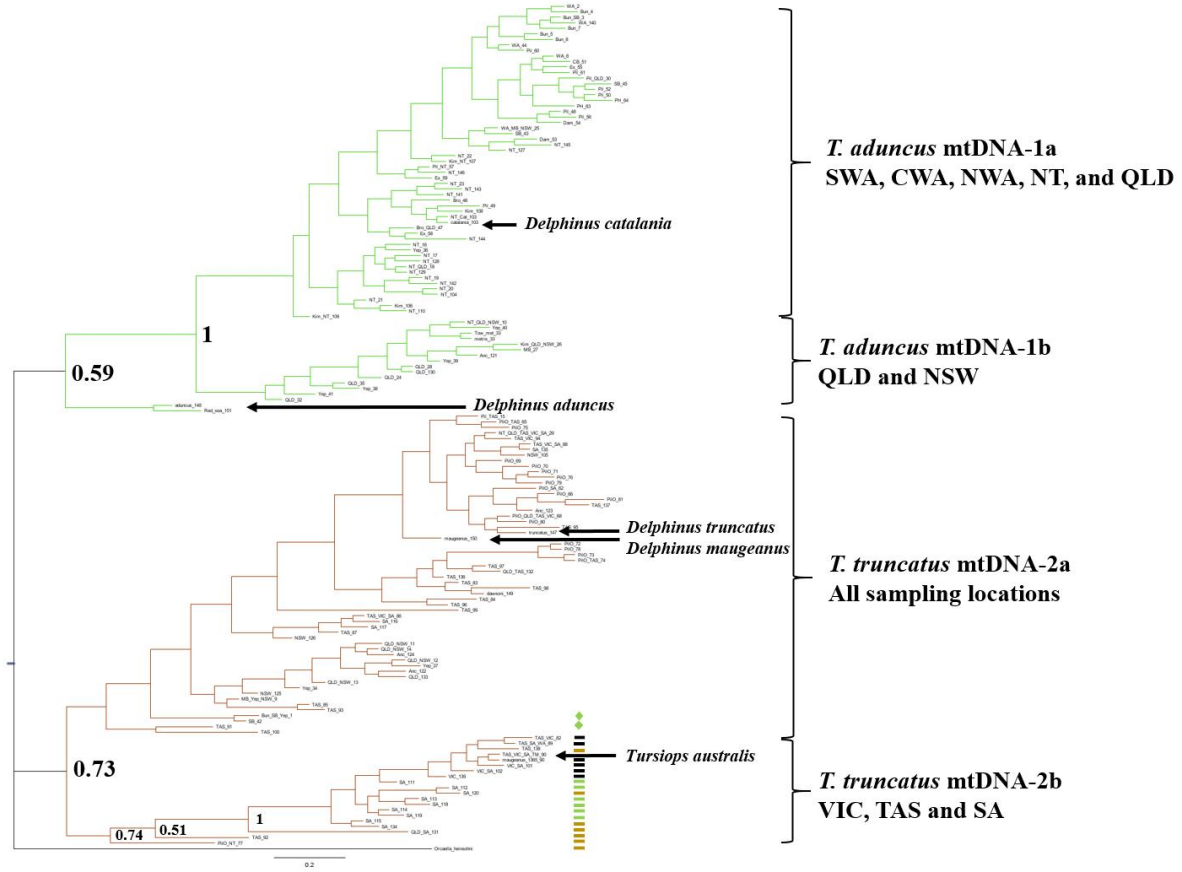

Figure 4.5. Bayesian Inference tree of all 150 mtDNA *Tursiops* spp. haplotypes found in the study, including type specimens. Two main cluster were apparent, with mtDNA *T. aduncus* containing individuals from group autosomal *T. aduncus*, and mtDNA *T. truncatus* individuals from group autosomal *T. truncatus*. Green diamonds = two haplotypes from CWA and SWA that cluster with group autosomal and Y-chromosomal *T. aduncus*, green rectangles = seven haplotypes from SA, including previously identified SABD from South Australia and southern Western Australia (Bilgmann *et al.* 2007, Pratt *et al.* 2018), that cluster with group autosomal and Y-chromosomal *T. aduncus*, brown rectangles = haplotypes identified as *T. truncatus* by all three genetic markers, black triangles = six haplotypes previously identified as *T. australis* (Charlton-Robb *et al.* 2011). The type specimens are marked out with an arrow. From the top in group mtDNA *T. aduncus* is the holotype of *T. aduncus* and type specimen of *D. catalania*, in group mtDNA *T. truncatus* is the type specimen of *D. maugeanus*, the holotype of *D. truncatus* and type specimen of *T. australis* at the bottom. Shown is also the subgroups and states/territory individuals within each cluster is from geographically.

Genetic differentiation among sampling locations

Comparison of Φ_{ST} between sampling locations showed a similar pattern to those revealed by F_{ST} and R_{ST}. While there were significant levels of differentiation between most sampling locations on the west, north and east coasts (Supporting Tables S4.9 and S4.10), sampling locations in close geographic proximity were less differentiated. We found a similar pattern in southern Australia for most sampling locations (Supporting Tables S4.10).

Y-chromosomal data

There were seven segregation sites (six single-nucleotide-polymorphisms and one insertion/deletion polymorphism) in the 1,411 base pairs of the concatenated Y-CATS loci, in which there were five unique haplotypes (Supporting Tables S4.11). A Bayesian reconstruction of the Y-chromosomal phylogeny revealed two major clades (Fig. 4.6). One major clade contained individuals identified as *T. aduncus*. There were four haplotypes

(Supporting Tables S4.11) in this clade, divided into two subclades. Samples from SA and southern WA clustered together in one subclade, sharing only one unique haplotype (Fig. 4.6). The second major clade of the Y-chromosomal phylogeny contained individuals identified as *T. truncatus* and *T. australis*, having only a single haplotype for all samples (Fig. 4.6, Table 4.2).

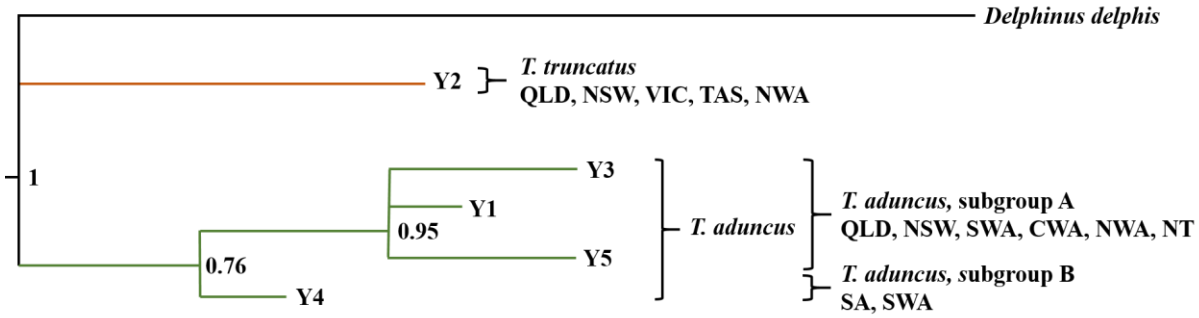

Figure 4.6. Bayesian Inference tree of all five Y-chromosome *Tursiops* spp. haplotypes found in the study. Two main clusters were apparent, Y *T. aduncus* and Y *T. truncatus*. Cluster Y *T. aduncus* was subdivided into two groups, with samples from SA, and some samples from SWA separated from samples from QLD, NSW, CWA, NWA and NT. Shown is also the geographical sampling location for each cluster. QLD = Queensland, NSW = New South Wales, VIC = Victoria, TAS = Tasmania, and SA = South Australia, SWA = southern Western Australia, CWA = central Western Australia, NWA = northern Western Australia, and NT = Northern Territory.

Overall patterns of nuclear, mtDNA and Y-chromosome data

When comparing and qualitatively combining the results of all three marker systems for all samples, samples representing *T. aduncus* and *T. truncatus*/*T. australis* could be further divided into four and two genetic groups, respectively (Table 4.2, Supporting Fig. S4.12). All individuals sampled north of approximately 35°S on the east coast and approximately 24°S on the west coasts showed concordance, *i.e.*, samples could be unambiguously assigned to either *T. aduncus* (Group I, Table 2 and Supporting Fig. S4.12) or *T. truncatus* (Group V, Table 4.2 and Supporting Fig. S4.12) for all three marker systems (global STRUCTURE analysis, *K*=2).

South of these latitudes however, individuals revealed mixed characters with respect to their marker systems, leading to three additional groups for *T. aduncus* (Groups II-IV) and one for *T. truncatus*/*T. australis* (Group VI), based on the combination of three genetic marker systems (Table 4.2). Group II, representing *T. aduncus* on the central western coast, was well embedded in *T. aduncus* for nuclear DNA (global STRUCTURE analysis, *K*=2) and Y-chromosomal markers (Table 4.2, Appendices 1 and 6). However, individuals with two particular mtDNA haplotypes (haplotype 1 and 41) clustered with *T. truncatus* for the mtDNA (Table 4.2).

Group III, sampled in southern WA, was well embedded in *T. aduncus* for nuclear DNA (global STRUCTURE analysis, *K*=2). However, there were also individuals with two haplotypes (1 and 41 as in Group II) clustering with *T. truncatus* for the mtDNA. Additionally, individuals from Group III formed their own well-supported subclade for Y-chromosomal data with *T. aduncus*. Group IV, from the southern coast, was well embedded

in *T. aduncus* for nuclear DNA (global STRUCTURE analysis, *K*=2) and Y-chromosomal markers, but clustered in *T. truncatus* subgroup B (with *T. australis*) for the mtDNA. This Group contained individuals with mtDNA haplotypes previously identified as SABD. Group VI, representing *T. australis*, was well embedded in *T. truncatus* for nuclear DNA (global STRUCTURE analysis, *K*=2, but formed its own group at *K*=4 with other samples from TAS and SA, Figs. 4.1C and 4.1D), Y-chromosomal markers, and also mtDNA (albeit forming their own, well supported subclade within *T. truncatus*).

Southern Australian Bottlenose Dolphin and Tursiops australis — A comparison of mtDNA results to Möller *et al.* (2008) was not possible as SABD mtDNA haplotypes were not available. Bilgmann *et al.* (2007) reported ten SABD mtDNA haplotypes. These were confirmed by Pratt *et al.* (2018), plus the description of another three SABD haplotypes that were unavailable for comparative purposes in our study. In our dataset, we described six of the ten haplotypes that were available. These clustered in the second major mtDNA clade, comprising of *T. truncatus* and *T. australis*. For autosomal and Y-chromosomal markers, however, these individuals appeared to be *T. aduncus* (Tables 4.2 and 4.3, Supporting Table S4.7).

Table 4.3. Species identification comparison for *Tursiops* spp. based on mtDNA haplotypes found in the present study and those found for southern Australian bottlenose dolphin (SABD) or *T. australis*. Discordant species identification between studies in bold and marked with *.

Haplotype present study	Sampling location present study	Species ID present study	Haplotype and species/group ID	Source
H82	VIC, TAS	*T. australis*	Burru8, *T. australis*	Charlton *et al.* 2006, Charlton-Robb *et al.* 2011
H89	TAS, SA	*T. australis*	Burru7, *T. australis*	Charlton *et al.* 2006, Charlton-Robb *et al.* 2011
H90	VIC, TAS, SA	*T. australis*	Burru6, *T. australis*	Charlton *et al.* 2006, Charlton-Robb *et al.* 2011
H101	VIC, SA	*T. australis*	Burru1, *T. australis*	Charlton *et al.* 2006, Charlton-Robb *et al.* 2011
H102	VIC, SA	*T. australis*	Burru2, *T. australis*	Charlton *et al.* 2006, Charlton-Robb *et al.* 2011
H139	VIC	*T. australis*	Burru3, *T. australis*	Charlton *et al.* 2006, Charlton-Robb *et al.* 2011
H111	SA	*T. aduncus*	H02, **SABD***	Bilgmann *et al.* 2007, Pratt *et al.* 2018
H112	SA	*T. aduncus*	H03, **SABD***	Bilgmann *et al.* 2007, Pratt *et al.* 2018
H113	SA	*T. aduncus*	H04, **SABD***	Bilgmann *et al.* 2007, Pratt *et al.* 2018
H114	SA	*T. aduncus*	H01, **SABD***	Bilgmann *et al.* 2007, Pratt *et al.* 2018
H118	SA	*T. aduncus*	H05, **SABD***	Bilgmann *et al.* 2007, Pratt *et al.* 2018
H119	SA	*T. aduncus*	H10, **SABD***	Bilgmann *et al.* 2007, Pratt *et al.* 2018

Six mtDNA haplotypes had previously been identified as belonging to *T. australis* (Table 4.3, Charlton-Robb *et al.* 2011, Charlton *et al.* 2006). In our study, individuals carrying these haplotypes were well embedded in *T. truncatus* for Y-chromosomal markers (Table 4.2, Supporting Table S4.7). For nuclear DNA, these individuals were well embedded in *T. truncatus* at *K*=2, but formed their own group at *K*=4 with other samples from TAS and SA.

4.5. Discussion

Our results supported two clusters of *Tursiops* spp., in Australian waters below certain latitudes. These clusters, appeared to be aligned with *T. aduncus* and *T. truncatus* (as for some areas identified in Allen et al. 2016 and Kemper 2004) as they showed concordance in autosomal, mtDNA and Y-chromosomal data. However, the pattern was far more elaborate in

southern Australian waters, where we identified several genetic groups. Some of these groups might occur in sympatry and possess mixed character sets in terms of genetic marker systems, suggesting episodes of past introgressive hybridization, recent radiations, or a combination thereof.

Support for the third *Tursiops* species in Australian waters, *T. australis*, was inconclusive as we did not find clear levels of concordance for *T. australis* across all three marker systems. Y-chromosomal markers were identical for *T. australis* and *T. truncatus*, while mtDNA haplotypes previously identified as *T. australis* by Charlton-Robb *et al.* (2011) clustered within *T. truncatus*, albeit as a major subclade, reciprocally monophyletic to the other major *T. truncatus* subclade. Kingston *et al.* (2009) and Gray *et al.* (2018) report similar mtDNA findings. Furthermore, STRUCTURE analyses involving all samples revealed that individuals with these particular mtDNA haplotypes formed their own group only at level K=4, which is unexpected for individuals presumably being members of higher taxonomic levels.

Another reason for why our results were inconclusive with regards to *T. australis* was that individuals from Group IV, at the central southern coast (sampling location SA), appeared to belong to *T. aduncus* based on autosomal and Y-chromosome markers, but clustered with *T. truncatus/T. australis* for mtDNA data (Table 4.3, Fig. 4.5). Kemper (2004) proposed the occurrence of both *T. aduncus* and *T. truncatus* in South Australian waters based on morphological assessments of stranded dolphins. Möller *et al.* (2008) later suggested that one group was incorrectly identified and instead representing SABD, which was also supported by other studies (Bilgmann *et al.* 2007, Moura *et al.* 2013, Pratt *et al.* 2018). For ease of comparing our results to previous studies, the names *T. australis* and SABD will still be used hereafter as defined above (Bilgmann *et al.* 2007, Charlton-Robb *et al.* 2011, Pratt *et al.* 2018).

Inferring species history from gene trees derived from single-sex markers such as mtDNA is problematic, because such makers may reveal other evolutionary processes than phylogenetic descent, blurring phylogenetic inferences (Leaché and McGuire 2006, McGuire *et al.* 2007, Mila *et al.* 2011). Two such processes are recent population divergence, which may cause incomplete lineage sorting, and historical introgression, the transfer of the entire mtDNA genome of a species into a closely related species through hybridization (Mila *et al.* 2011, Toews and Brelsford 2012). Our data for SABD were not parsimonious with incomplete lineage sorting, as *T. aduncus* and *T. australis* appear to share a recent common ancestor to the exclusion of *T. truncatus* for mtDNA, while our autosomal results suggest *T. australis* and *T. truncatus* being more closely related (McGuire *et al.* 2007). Furthermore, one would expect individuals with mixed ancestry to be randomly distributed throughout *T. aduncus'* range, rather than concentrated near the geographical area of contact (McGuire *et al.* 2007, Toews and Brelsford 2012), as we found in this study.

Our data were consistent with unidirectional mitochondrial introgression from *T. australis* into *T. aduncus* in South Australia, as indicated by Group IV, with no or little detectable nuclear introgression based on the STRUCTURE analysis. Since *T. aduncus* mitochondrial

haplotypes in South Australia appear to be derived from *T. australis* rather than shared, it is conceivable that *T. aduncus* has received these haplotypes by introgression in the past, rather than through the persistence of ancestral polymorphism in both species (Pons *et al.* 2014). Such patterns have been documented from a wide range of organisms (reviewed by Toews and Brelsford 2012), including birds (Irwin *et al.* 2009, Mila *et al.* 2011, Pons *et al.* 2014), chipmunks (Good *et al.* 2008) and newts (Zieliński *et al.* 2013). Unidirectional mating and sex-biased dispersal are unlikely scenarios for the observed pattern as this would have required extreme female-mediated gene flow to increase the mtDNA frequency in South Australian *T. aduncus* to such high frequency (Pons *et al.* 2014). Recent hybridization also appears unlikely, as under such a scenario, comparable nuclear introgression would be evident. Although, inter-species hybridization has been observed both in captive (Gridley *et al.* 2018, Zornetzer and Duffield 2003) and wild cetaceans (Brown *et al.* 2014), *Tursiops aduncus* and *T. truncatus* are considered currently reproductively isolated from each other (Allen *et al.* 2016), which is supported by our data.

Globally, *T. truncatus* is found in tropical and temperate latitudes, in both deep and shallow waters, and both costally and offshore (Rice, 1998; Reeves *et al*., 2002). In Australian waters, we identified *T. truncatus* as occuring offshore, at least in all locations with sampling. The origin of *T. truncatus* and *T. australis* in Australian waters has yet to be determined, with our data not being able to resolve this debate. Moura *et al.* (2013) proposed an Australasian origin for *Tursiops*, supported by Gray *et al.* (2018), with SABD in southern Australia being basal to all other *Tursiops*. However, we question this because, despite descending from a deep node, the radiation of *T. australis* is much more recent (within the past 212 kya) than that of *T. aduncus* and *T. truncatus* (Cornaz 2015, Moura *et al.* 2013).

The current distribution thus cannot be assumed to reflect the geographical origin of *Tursiops* spp. A contrasting hypothesis is that *T. australis* arose via a founder event from a pelagic ancestor resembling *T. truncatus* (Cornaz 2015). Our finding that *T. australis* shows high affinity to *T. truncatus* based on autosomal data supports this idea. It is important to note, however, that SABD samples used by Moura *et al.* (2013) and Gray *et al.* (2018) were from coastal South Australia and species identification from Möller *et al.* (2008). Our results indicate that these individuals were likely *T. aduncus*, carrying a *T. australis* haploptype as a result of mtDNA introgression.

The range of *T. australis* appears limited to southeastern Australia (Victoria and parts of Tasmania) in the east (Charlton-Robb *et al.* 2011) and to eastern parts of coastal South Australia to the west (this study). In South Australia, we identified six *T. australis* specimens. As these specimens were collected from stranded animals and thus have poor provenance, we could not determine whether *T. australis* occurs in sympatry or parapatry with other *Tursiops* species in this area. Overall, there remains a lack of adequate data to draw further conclusion about the potential based on our data, it is also conceivable that *T. truncatus* and *T. australis* occur in parapatry along the east coast of Tasmania. As yet, there remains a lack of adequate data to draw further conclusions about the potential geographic overlap of *T. truncatus* and *T. australis* along the open coastline of Victoria, Tasmania, South Australia and further

offshore. Future studies with more adequate sampling regimes will need to address these important questions.

The potential occurrence of some of the genetic groups in sympatry might be explained by resource specialization present and historic oceanographic processes, or a combination therof (Bunt 1987, Wilson and Allen 1987, Hoelzel 1998, Commonwealth of Australia 2015). Genetic differentiation as a result of resource specialization or limitations occur commonly in sympatric fish, birds and amphibians, which can manifest in morphological differences, life-history and behavioral specializations (Roy *et al.* 2007, Skúlason *et al.* 1993, Smith and Skúlason 1996). In addition, intraspecific genetic differentiation patterns within geographic regions, as a result of resource specialization for example, can occur for populations in sympatry or parapatry, and even within populations (Hoeltzel and Dover 1991, Hoeltzel 1998, Kopps *et al.* 2014, Möller *et al.* 2007).

The eastern geographical limitation of *T. australis* might have been caused by challenging oceanographic conditions around Bass Strait in terms of salinity, water temperature, currents – as reported for *T. truncatus* in South Africa (Ross 1977, 1984), and recurrent sea-level changes (Bunt 1987, Frakes *et al.* 1987, Wilson and Allen 1987, Commonwealth of Australia 2015). The ongoing sea-level changes during the last two million years have resulted in recurrent connections of Tasmania to the Australian continent in Bass Strait (Frakes *et al.* 1987). During glacial periods, when Bass Strait was closed, populations to the west may have diverged from those further east. However, isolation might not have been sufficiently long to cause reproductive isolation, so that taxa came back into contact during inter-glacials. These recurrent connections might also explain the existence of *T. australis* on the east coast of Tasmania, although Charlton-Robb *et al.* (2015) found current gene flow between eastern Tasmania and coastal Victoria for *T. australis*.

It is challenging to define and diagnose species rank without moving the taxonomic boundaries when adopting different species concepts. Guidelines to assist in the assessment of species is lacking for cetaceans but have been developed, for example, for birds (Helbig *et al.* 2002), where taxa can be seen as fully diagnosable if A) individuals within a taxa possess one or more discrete characteristics that members of other taxa lack; B) that there is at least one character with no overlap with other taxa; or C) there is a combination of two or more dependent characters (morphological and genetic) to separate from other taxa that are not diagnosable on its own (Helbig *et al.* 2002). None of these could be found for *T. australis* based on morphological or genetic results, where *T. australis* clustered well within *T. truncatus* (Jedensjö et al. in review).

Having said this, however, there are conservation units below species level that are important in management and conservation (Fraser and Bernatchez 2001). The genetic criterion for recognising evolutionary significant units (ESUs) is when two populations have achieved reciprocal monophyly for mtDNA and show significant divergence of allele frequencies at nuclear loci (Moritz 1994). Based on these definitions and our results, *T. australis* definitely represents one of these units. However, it is important to note that taxonomic

recommendations are hypotheses of relationships of taxa available at the time and are therefore subject to reinterpretation in particular when new results become available (Helbig *et al.* 2002).

Future analyses

Our study highlights the importance of including different genetic marker systems with different evolutionary histories when addressing questions of taxonomic importance, as well as utilizing comparative morphology. For the taxonomic group in question, there remains an urgent need to develop large scale nuclear markers using next generation sequencing techniques that allow the explicit testing of different demographic scenarios in Bayesian frameworks, such as Approximate Bayesian Computation (ABC, Csilléry *et al.* 2010). That or similar approaches would greatly aid in determining important demographic population parameters such as split order, split time, occurrence or cessation of gene flow as well as its direction, and also in determining the extent of potential introgressive hybridization event, such as mtDNA 'swamping'. Furthermore, a more dedicated sampling effort is required to fill certain sampling gaps around the vast Australian coast, especially in areas where the three *Tursiops* taxa appear to occur in sympatry or parapatry, so that still outstanding taxonomic uncertainty in the genus *Tursiops* could be resolved.

4.6. Acknowledgments

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Chapter 5

General Discussion

This thesis sought to resolve the taxonomic status of Australian *Tursiops*, using a combination of morphological (2D and 3DGM) and genetic (mtDNA, autosomal and Y-chromosomal markers) methods, using the most comprehensive sampling effort to date. In this chapter, I summarize the main findings for *Tursiops* (Chapters 2-4), discuss the implications of this research and outline potential future work.

5.1. Taxonomic issues and status of Australian *Tursiops* prior to my study

The family Delphinidae and the genus *Tursiops* in particular have experienced a complex evolutionary history. Relationships within the family have been widely debated because they are difficult to solve using either morphological or genetic methods (LeDuc *et al*. 1999, McGowen, 2011, Amaral *et al*. 2012, Perrin *et al*., 2013), or a combination of these as they do not produce concordant results (Perrin 2013). For Australian *Tursiops*, a comprehensive morphological and genetic study has not been attempted. The goal is to identify and describe species so that phenotypical and genetic differences are maintained even when in contact with other populations or taxa (Helbig *et al.* 2002). Complications arise when results from multiple analyses appear to contradict each other (Mallet 1995, Helbig *et al.* 2002, Kurihara and Oda 2007). For instance, morphological methods may not always show the true number of biological species because characters can arise as a result of functional evolution rather than ancestry (Bickford *et al*. 2007, Perrin 2013). Furthermore, there may be a lack of none-overlapping diagnosable characters that could result in taxa to be recognised as ecotypes rather than nominal species (Case *et al.* 1998, Carvalho-Filho *et al.* 2010).

In contrast, genetic methods can be problematic because they do not always reveal evolutionary processes based on true phylogenetic descent (Leaché and McGuire 2006, McGuire *et al.* 2007, Mila *et al.* 2011). Such patterns have been observed in taxa with recent and rapid radiations such as the family delphinidae (McGowen 2011, Nikaido *et al.* 2007, Perrin 2013). Some genetic studies have concluded that *T. aduncus* and *T. truncatus* may each be more closely related to other genera than to each other (LeDuc *et al*., 1999, Kingston *et al*., 2009, Moura *et al*., 2013). Morphological studies have shown species within this genus can be distinguished from *Stenella* and *Delphinus* by, for example, fewer vertebrae and teeth (Perrin 1975, Wells and Scott 1999, Perrin 2001, Shirakihara et al. 2003).

Resolving some of these issues using either morphological or molecular data might not be possible using current methods (Perrin 2013). Since evolution and speciation are continuous processes, trying to artificially partition taxa into discrete groups that have biological meaning (Helbig *et al.* 2002) may not be possible.

In Australian waters, *T. aduncus* and *T. truncatus* are found in most places, but have been identified genetically in only three locations (Möller and Beheregaray 2001, Charlton-Robb

et al. 2011, Allen *et al*. 2016). Morphologically, *T. aduncus* and *T. truncatus* have been identified in two locations, but these have not been compared genetically (Hale 2000, Kemper 2004). The recently named *T. australis* was described using genetic and morphological data (Charlton-Robb *et al.* 2011), but has not been accepted as a distinctive nominal *Tursiops* species (Committee on Taxonomy 2018). In this thesis, I expand on previous morphological and genetic studies on Australian *Tursiops* by substantially increasing the sample size and coverage. The first step was to investigate if the genus *Tursiops* could be morphologically distinguished from most of the other delphinid taxa present in Australian waters (Chapter 2), the second was to identify how many *Tursiops* species are present using skeletal morphology (Chapter 3), and the third was to use genetic techniques to identify species and compare these results for each specimen to the morphological results (Chapter 4).

5.2. Morphological characteristics of *Tursiops* spp. in Australian waters

A morphological (2D and 3DGM) comparison of some delphinids that occur in Australian waters found that *Tursiops* spp., including *T. australis* and type specimens, formed a monophyletic group that could clearly be separated from other genera (Chapter 2). My results challenges previous mtDNA genetic conclusions indicating polyphyly for *Tursiops* (LeDuc *et al.* 1999, Kingston *et al.* 2009, Xiong *et al.* 2009, Moura *et al.* 2013). This is not surprising given that mtDNA as a clonally inherited marker that does not always reveal correct phylogenetic relationships (Avise *et al.* 1987, Zhang and Hewitt 2003, Leaché and McGuire 2006, McGuire *et al.* 2007, Mila *et al.* 2011). Previous morphological studies found separation between *Tursiops* spp., *Delphinus* and *Stenella* using number of teeth and vertebrae, as well as cranial shape (Perrin 1975, Wells and Scott 1999, Perrin 2001, Shirakihara *et al.* 2003, Amaral *et al.* 2009). Cladistic analyses of some taxa are available (Perrin *et al.* 1987, de Muizon 1988, Geisler *et al.* 2011, Murakami *et al.* 2014), but a comprehensive morphological study of delphinids worldwide is needed.

Morphological support for Australian T. aduncus *and* T. truncatus

Analyses of morphological data for Australian specimens, found support for two species, *T. aduncus* and *T. truncatus* (Chapter 3). The results showed the importance of size and shape in separating groups, as well as lack of non-allometric influence. Width and length of skull and rostrum were important discriminators for both 2D and 3GM, with *T. aduncus* having a rounded cranium compared to the more angular *T. truncatus*. These findings agreed with other studies in Australia and globally (Ross 1977, Hale *et al*. 2000, Wang et al. 2000*b*, Kemper 2004, Kurihara and Oda 2007, Amaral *et al.* 2009). However, an overlap in skull length between these species was identified, and has been observed by others (Ross 1977, Wang et al. 2000*a*, 2000*b*, Kemper 2004) and, this made it difficult to separate species using meristic data. For my 2D data, there was not complete separation between *T. aduncus* and *T. truncatus*, and as a consequence, 13 specimens could not be assigned to species. These were intermediately-sized skulls that came from around the coast of Australia. *Tursiops australis* was not included in these intermediates. Categorical and count variables have also proven informative in studies carried out elsewhere (Ross 1977, Wang et al. 2000*a*, Kemper 2004),

but the results were not consistent between regions. I found that *T. aduncus* had fewer vertebrae, more teeth, and more erosion on the frontals and pterygoids than *T. truncatus*. Comparison of meristic data from Australia, China, South Africa and Japan showed that both *T. aduncus* and *T. truncatus* overlapped in size. Interestingly, Australian *T. aduncus* was much smaller, while Australian *T. truncatus* was larger than conspecifics from China, but smaller than those from Japan and South Africa. Some of these intraspecific variation could be related to environmental adaptations between widely-spaced populations (Perrin 1984, Heyning and Mead 1996, Rice 1998, Perrin et al. 1999).

***Morphological support for* T. australis**

In my study I found little morphological evidence to support *T. australis* as a nominal *Tursiops* species. *Tursiops australis* was named using both genetic and morphological data, where it was morphologically described as intermediate in size between *T. aduncus* and *T. truncatus*, and distinguished using four diagnostic skull features (Charlton-Robb et al. 2011). However, the lack of recognition as a distinctive nominal *Tursiops* species is due to the small sample size, restricted geographical coverage for comparison within Australian waters, low support using molecular data, some overlap in metric characters and the lack of comparison with *Tursiops* from other global regions and type specimens (Committee on Taxonomy 2018). I was able to resolve some of these issues in my thesis. My results showed that *T. australis* fell within *T. truncatus* at the highest level for both morphological methods, and could not be distinguished for any of the features, including the ones used to name it as a separate species. In addition, comparison of meristic data between *T. australis* to those from China, South Africa and Japan also overlapped in size. In conclusion, it appears to be impossible to identify *T. australis* morphologically for 2D or for 3DGM methods without prior species identification. Thus, my data do not warrant *T. australis* to be a distinctive nominal *Tursiops* species. For ease of referencing to previous studies, I use the name *T. australis* hereafter to relate to specimens found in Victoria and Tasmania that were identified by Charlton-Robb *et al.* (2011). The southern Australian bottlenose dolphin (SABD) is used hereafter to relate to specimens found in South Australia and southern Western Australia that were identified by Bilgmann *et al.* (2007) and Pratt *et al.* (2018).

5.3. Genetic support for Australian *T. aduncus* and *T. truncatus*

Genetic data for Australian *Tursiops* spp. specimens, identified *T. aduncus* and *T. truncatus* (Chapter 4). This supported previous studies based on a global mtDNA comparisons that have confirmed *T. aduncus* in northwestern and southeastern Australia (Möller and Beheregaray 2001, Moura *et al.* 2013, Allen *et al.* 2016), and *T. truncatus* in northwestern and southeastern Australia (Möller *et al.* 2008, Charlton-Robb *et al.* 2011, Allen *et al.* 2016). *Tursiops truncatus* was identified in locations where there was adequate inshore and offshore sampling, and showed concordance when analyzing autosomal, mtDNA and Y-chromosomal data. The same was true for *T. aduncus* north of certain latitudes (approximately 35°S on the east coast and 24°S on the west coasts). However, *T. aduncus* in South Australia and some *T. aduncus* on the west coast clustered with *T. truncatus* for the mtDNA, suggesting episodes of recent radiation, hybridization and, introgression or a combination thereof.

In central and southern Western Australia, individuals with two of the mtDNA haplotypes clustered with *T. truncatus*, while these same individuals clustered with *T. aduncus* for autosomal and Y-chromosomal markers, as well as morphologically. These mtDNA haplotypes were also found by Krützen *et al.* (2004) in central Western Australia. The authors showed that these two mtDNA haplotypes occurred with other *T. aduncus* within the same panmictic population, suggesting that incomplete lineage sorting between *T. truncatus* and *T. aduncus* haplotypes was responsible for this pattern (Krützen *et al.* 2004). Interestingly, these mtDNA haplotypes were restricted to central and southern Western Australia and not found further north or along the southern coast.

For the central southern coast, I identified individuals that clustered with *T. aduncus* for autosomal and Y-chromosomal markers (Chapter 4), and morphological characteristics (Chapter 3), but with *T. truncatus/T. australis* for mtDNA (Chapter 4). These mtDNA haplotypes were the same or closely related to those found in previous studies (Bilgmann *et al.* 2007, Möller *et al.* 2008, Moura *et al.* 2013, Pratt *et al.* 2018), in which species identification of all individuals bearing these haplotypes were assumed to be *T. australis*/SABD. However, I identified these as *T. aduncus* (because I included morphological, autosomal and Y-chromosomal data), supporting the morphological results reported by Kemper (2004).

Recent studies have shown that natural hybridization and potential introgression occur in about 10% of animal species, where as many as 43% of some bird species hybridize, and 25% of plant species (Mallet 2005). My data suggest that introgressive hybridization may have occurred (Chapter 4). The cause of this complete unidirectional introgression from *T. australis* into *T. aduncus* is unknown. However, such patterns of introgression have been documented in a wide range of organisms (Good *et al.* 2008, Irwin *et al.* 2009, Toews and Brelsford 2012, Zieliński *et al.* 2013, Pons *et al.* 2014), possible causes include demographic and selective processes (Currat *et al.* 2008, reviewed by Toews and Brelsford 2012). Future analyses including demographic modelling on autosomal data and/or genomic analyses on admixture proportions might help to address these questions in more details.

5.4. Morphological and genetic results for type specimens

The type specimen of *D. catalania*, collected from Queensland (northern Australia) aligned well with *T. aduncus* for both morphological and genetic data. The type specimen of *D. aduncus*, collected from the Red Sea, bore resemblance to both *T. aduncus* and *T. truncatus* for the 2D morphology. The specimen was larger than Australian *T. aduncus*, as were other specimens in general from that region (South Africa). This most likely relates to environmental adaptations, for example water temperature, between widely-spaced populations (Perrin 1984, Heyning and Mead 1996, Rice 1998, Perrin et al. 1999).

The type specimens for *T. truncatus* showed evidence of less morphological adaptations between regions (Chapter 3). *Delphinus truncatus*, collected from the United Kingdom, and *T. maugeanus*, collected from Tasmania, aligned well with *T. truncatus* both in the morphological and genetic approach. Both type specimens were larger than most Australian

Tursiops individuals (2D analysis), most likely because they were sampled in colder water environments. The type specimen of *T. australis*, collected from Tasmania, aligned well with *T. truncatus* in terms of morphology but did not align well with other *T. australis* specimens for most analyses, suggesting that it might not be a suitable type specimens to represent *T. australis*.

5.5. Genetic identification and conclusions for *T. australis*

I found little morphological evidence to support *T. australis* as a nominal species, regardless of the analytical method used (Chapter 4). My data also showed that neither Y-chromosomal nor autosomal markers could be used to identify *T. australis*. Furthermore, I demonstrated that relying on mtDNA alone for species identification would be misleading in many cases, especially *T. australis*. In terms of genetic analyses, *T. australis* was named based on six unique haplotypes that clustered reciprocal monophyletically with other *T. truncatus* (Charlton-Robb *et al.* 2011). Möller *et al.* (2008) also included autosomal data. However, my Y-chromosomal and autosomal markers failed to distinguish *T. australis* and *T. truncatus*, because Y-chromosomal markers were identical for *T. australis* and *T. truncatus*, and autosomal markers separated only *T. australis* and *T. truncatus* at *K*=4 (the names *T. australis* and SABD are used hereafter as defined above for the morphological results).

I expanded the sample size and Australian coverage extensively compared to prior studies, and I compared to *Tursiops* spp. from other parts of the world, as well as to type specimens, which resulted in inconclusive morphological and genetic distinction between *T. australis* and *T. truncatus* rather than clarity. There are numerous species concept available, none which are completely objective (Helbig *et al.* 2002). The use of judgement always has to be used in borderline cases like *T. australis*, which can make the definition and ranking of species very difficult (Helbig *et al.* 2002). All species concepts require species to be diagnosable as a result of their own independent evolutionary histories, but varies in their prediction about the future; if any population that is recognizable should be a separate species independently of if it will or will not merge with other populations once they come into contact, or only to name species if we can be certain that they can maintain their integrity in the future (Helbig *et al.* 2002).

Species assignment for *T. australis* is not straightforward because of the complex and still unknown evolutionary relationship with *T. aduncus* and *T. truncatus* along the southern coast of Australia. First, the distributional relationship between *T. australis*, *T. aduncus* and *T. truncatus* is uncertain. We also do not know whether the three taxa occur in sympatry or parapatry, to what extent they hybridize with *T. aduncus* and *T. truncatus* and, if present, how large the hybrid zone might be. Second, if mtDNA is the sole marker used for species diagnosis, some *T. australis*, *T. truncatus* and *T. aduncus* will inadvertently cluster together. Third, *T. australis* is only diagnosable for autosomal and 3DGM data at a subgroup level when prior species identification (based on mtDNA) is known. It does not appear to have any non-overlapping morphological features compared to *T. truncatus*. Fourth, it is not distinguishable from *T. truncatus* for Y-chromosomal and 2D morphology data. Based on these results, if *T. australis* is to be recognized as a distinctive nominal *Tursiops* species,

mtDNA appears to be the only diagnosable feature. However, due to the smaller effective population size and the general trend of female philopatry in inshore cetaceans (*e.g.* Krützen *et al.* 2004, Allen *et al.* 2016), lineage sorting for this marker system is achieved much faster than that for autosomal markers, even between fairly recently isolated populations. Based on the current knowledge at hand, I deem it questionable whether *T. australis* constitutes a distinctive nominal *Tursiops* species.

However, apart from species assignments, one can define units important for conservation and management, such as evolutionary significant units (ESUs) or management units (MUs, Moritz 1994, Fraser and Bernatchez 2001). Evolutionary significant units can be defined as two populations that have achieved reciprocal monophyly for the mtDNA, and show significant divergence of allele frequencies at nuclear loci (Moritz 1994). Thus, *T. australis* might constitute an ESU, especially if future analyses could show their demographic independence and isolation from other *Tursiops* populations in this area.

5.6. Geographic patterns

Tursiops aduncus and *T. truncatus* were found around most of the Australian coast except the Northern Territory, where specimens aligned with *T. aduncus*, and Bass Strait, where only *T, truncatus* was identified. The pattern in the Northern Territory fits with the general pattern previously described for *T. aduncus*, being associated with shallow waters on the continental shelf (Ross 1984, Hoelzel *et al*. 1998, Rice 1998, Reeves *et al*. 2002), even when this extend more than 250 km from shore (Harwood and Hembree 1987).

The reason for the absence of *T. aduncus* in Victoria and Tasmania (southeastern Australia), especially in the shallow Bass Strait, is still unknown, but possible explanations could be oceanographic conditions (Wilson and Allen 1987, Bunt 1987, Commonwealth of Australia 2015) and/or the presence of *T. australis* in this region. The most plausable explanation is the fact that southeastern Australia is oceanographically complex. Several major currents meet in this region: the East Australian Current and Leeuwin Current bring warm waters from the north and the Zeehan Current, cold water from the south (Commonwealth of Australia 2015). These currents create unique water conditions in terms of salinity, water temperature and water flow (Bunt 1987, Wilson and Allen 1987, Commonwealth of Australia 2015), potentially influencing the distrubution of *Tursiops* spp. A similar senario has been reported from South African waters, where *T. truncatus* occurs inshore on the west coast and offshore along the south and southeast coast due to the occurence of warm and cold currents (Ross 1977, Ross 1984).

Interestingly, the ranges of *T. australis* and *T. aduncus* appear to be adjacent. However, the full extent of the distribution of *T. australis* is not known. My study and those of Charlton-Robb *et al*. (2011, 2015) showed that *T. australis* is limited to Victoria and Tasmania, but I also found a few individuals with *T. australis* mtDNA haplotypes in South Australia, which suggests that its range may extend further west. What is less clear is the distributional relationship between *T. australis* and *T. truncatus* (*i.e.* sympatric, parapatric, allopatric,

hybrid zone). Nonetheless, both well-described *T. australis* populations seem to occur either in protected and enclosed bays in Victoria, or in open coastal habitat in Tasmania (Charlton *et al.* 2011, 2015). However, no offshore samples have been collected from these areas. One of the coastal populations in Victoria appear to belong to the same population as the one on the eastern coast of Tasmania. The reason for this might be a result of closing of Bass Strait during glacial periods, when these populations were theoretically connected. After opening of Bass Strait and the occurrence of different environmental conditions, these populations might have adapted to different environments based on habitat or resource specialisation (Hoelzel 1998).

The restriction of an eastern and western distribution for *T. australis* could be a result of the presence of *T. aduncus* in combination with present and historic oceanographic processes for this region. The ranges of *T. australis* appears to abut that of *T. aduncus* on the eastern side, but seem to slightly overlap in distribution on the western side. On either side, there is a transitional bioregion including a large area of upwelling (Commonwealth of Australia 2015) that appear to act as an oceanographic barrier and limit the distribution of *T. australis* to the east, but not entirely to the west.

5.7. Future work

The results presented in my study are a first step towards solving the taxonomic status of Australian *Tursiops*, and to identify where future research is needed. There is still a need to fill certain sampling gaps (inshore/offshore sampling) and identify potential distributional barriers, both morphologically and genetically, and around the Australian coast and globally. While most areas in Australia appear to follow the classic inshore/offshore patterns of *T. aduncus* and *T. truncatus*, there are some interesting questions about the species in southeastern Australia. Further comparisons of this with another key area in the northeastern part (potential distributional barrier for coastal dolphins) might provide a more complete picture of Australian *Tursiops*. In order to achieve this, appropriate sampling and analytical methods need to be chosen, and results carefully interpreted.

My study design was crucial to establishing an Australia wide perspective on *Tursiops* taxonomy. However, what is needed is a comparison with bottlenose dolphins in the broader Indo-Pacific region and worldwide, as well as incorporating both morphological and genetic data. In addition, the relationship of *Tursiops* to other delphinids worldwide needs resolution. On a morphological level, the association of environment (inshore/offshore) and skeletal form needs to be explored in *T. aduncus*. Spencer Gulf in South Australia, for example, could serve as a study area because it is a large, semi-enclosed bay. Genomic analyses that allow testing of detailed demographic hypotheses and evaluate the degree and direction of admixture in individual genomes will allow to address some of the taxonomic uncertainties in southern Australia. These methods also may contribute to issues such as split order, split times, occurrence/absence of gene flow and mtDNA ‘swamping’. Answering these may enable us to, for example, explore if and to what extent introgression of *T. australis* mtDNA into *T. aduncus* might have occurred. In summary, the lack of taxonomic resolution of the

genus *Tursiops* for both morphological and genetic analyses prior to my work clearly showed the importance of an integrative apprach of the two complementary methods.

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7. Supporting Information

7.1. Chapter 2

Supporting Information S2.1. Specimens examined for the study by institution and taxa (name as allocated by the museum). Data include registration number, sex, locality, state and stranding date of the specimens used for the study. Missing data = ?.

Western Australian Museum, Perth: *Tursiops* spp.: M1192, ?, Swan River Estuary, WA, 26 September 1929; M1228, ?, Cape Leeuwin, WA, 11 March 1930; M2947, ?, Kukerin?, WA?, 6 August 1953; M4794, ?, Esperance, WA, 22 February 1958; M5723, ?, Rottnest Island, WA, 10 April 1963; M6384, F, Shell Bch, Peron Peninsula, WA, 29 October 1964; M6395, M, Swanbourne, WA, 26 November 1964; M6845, ?, Carnarvon area, WA, 8 March 1966; M7028, ?, Yallingup, WA, ?; M7044, ?, Long Is, Hontman Abrolhos, WA, 18 May 1905; M7499, ?, Point Peron, WA, 29 November 1966; M7584, ?, John Point (Garden Island?), WA, 25 January 1967; M7870, ?, Boranup, WA, 1 June 1967; M7871, ?, Manypeaks (Albany), WA, 17 December 1967; M7881, ?, ?, ?, ?; M9098, ?, Rockingham, WA, 27 November 1970; M11387, ?, Barrow Island, WA, 25 May 1905; M11940, ?, Baba Head, Shark Bay, WA, 14 August 1970; M11941, ?, Nanga Bay, near Shark Bay, WA, ?; M15245, ?, ?, ?, 17 May 1968; M15246, ?, Parry Inlet, WA, 1 September 1971; M15249, ?, Jurien Bay, WA, 21 January 1970; M15255, ?, Herald Bight, WA, 30 January 1977; M16293, ?, no data - John Dell's dam burial ground, WA?, ?; M16298, ?, Hopetoun, WA, 20 January 1983; M25813, ?, no data - skull found in collection, ?, ?; M26631, ?, Unknown, NT, 8 June 1905; M26633, ?, Unknown, ?, 8 June 1905; M28125, M, Unknown, NT, 1 October 1985; M28126, M, Elizabeth River, NT, 6 June 1905; M28127, F, Unknown, NT, 2 October 1985; M28131, M, Unknown, NT, 30 September 1984; M28135, M, NT, NT, 3 October 1985; M28136, M, Unknown, NT,1 October 1985; M28138, M, NT, NT, 30 September 1985; M28140, M, Unknown, NT, 11 October 1985; M28151, M, Unknown, NT,19 October 1985; M29122, ?, Garden Island, WA, 19 January 1989; M36671, ?, ?, WA, 1 September 1991; M42285, F, Nanya, Shark Bay, WA, 14 October 1992; M42286, ?, Dubaut Point, Monkey Mia, WA, 12 April 1993; M52395, ?, Monkey Mia, WA, ?; M54135, ?, Matilda Bay, Swan River, WA, 16 January 1979; M54141, F, Floreat Beach, WA, 15 September 1984; M55192, ?, Meerup Beach, WA, 6 August 1945; M60866, ?, ?, ?, ?, ***S. attenuata:*** 23109, ?, ?, ?, ?; M25830, ?, Barrack point, Augusta, WA, 01 June 1981; M25831, ?, Barrack point, Augusta, WA, 01 June 1981; M25832, ?, Barrack point, Augusta, WA, 01 June 1981; M25833, ?, Barrack point, Augusta, WA, 01 June 1981; M28143, M, ?, NT, 01 January 1986; M54138, M, ?, ?, 06 March 1975, ***S. coeruleoalba:*** M16231, F, Hardy Inlet, Augusta, WA, 01 March 1976; M16232, F, Hardy Inlet, Augusta, WA, 01 March 1976; M16233, F, Hardy Inlet, Augusta, WA, 01 March 1976; M16235, F, Hardy Inlet, Augusta, WA, 01 March 1976; M16237, F, Hardy Inlet, Augusta, WA, 01 March 1976; M23141, F, Hardy Inlet, Augusta, WA, 01 March 1976; M29125, F, Augusta, WA, 29 January 1989; M29127, F, Augusta, WA, 29 January 1989, ***S. longirostris roseiventris:*** M26623, M, ?, ?, 21 September 1984; M26625, M, Cape Londonderry, NT, 26 September 1984; M26629, F, Cape Londonderry, NT, 12 October 1984; M26630, F, ?, NT, 29 September 1985; M28132, F, ?, NT, 03 October 1985; M28141, M, ?, NT, 13 November 1985; M28142, M, ?, NT, 13 November 1985; M28149, M, ?, NT, 24 September 1985, ***S. sahulensis:*** M53798, ?, Exmouth, WA, 5 August 2003. **Museum and Art Gallery of the Northern Territory, Darwin: *Tursiops* spp.:** U0241, ?, Beach Ne. Murgenella, NT, 5 June 1985; U0513, M, Arafura Sea, NT, 13 August 1985; U0517, F, Arafura Sea, NT, 26 January 1984; U0521, F, Arafura Sea, NT, 14 August 1985; U0523, ?, Arafura Sea, NT, 21 January 1984; U0527, ?, Arafura Sea, NT, 3 December 1983; U0533, ?, Arafura Sea, NT, 13 October 1984; U0534, ?, Arafura Sea, NT, 9 December 1983; U0535, ?, Arafura Sea, NT, 1 December 1983; U0537, ?, Arafura Sea, NT, 1 December 1983; U0661, ?, Arafura Sea, NT, 10 December 1983; U0662, F, Arafura Sea, NT, 3 December 1983; U0665, M, Timor Sea, NT, 29 September 1984; U0691, ?, Arafura Sea, NT, 1 December 1983; U0693, ?, Arafura Sea, NT, 1 December 1983; U0694, F, Arafura Sea, NT, 9 November 1983; U0695, ?, Arafura Sea, NT, 13 October 1983; U3955, ?, Maria Island, NT, 27 July 1972; U3956, ?, Marchinbar Island-Cape Wessel, NT, 6 October 1972; U5095, ?, Unknown, ?, ?; U5635, ?, Bustard Island, Groote Eylandt, NT, 1 August 2006, ***S. attenuata:*** U356, ?, ?, ?, 31 November 1986; U664, F, Timor Sea, NT, 4 October 1984, ***S. longirostris:*** U244, M, ?, NT, 26 September 1984; U514, M, ?, ?, 20 June 1985; U516, F, Timor Sea, WA, 9 October 1984; U536, ?, Timor Sea, WA, 13 October 1984; U657, M, Arafura Sea, NT, 7 November 1983; U5088, ?, ?, ?, ***S. sahulensis:*** 528, ?, Channel Point, NT, 28 October 1988; U660, M, Arafura Sea, NT, 28 November 1983; U5150, ?, Black Point, Coburg, NT, 3 March 1996. **Museum of Tropical Queensland, Townsville: *Tursiops* spp.:** MM91A, ?, Great Palm Island, QLD, 12 July 1976; MM1018, ?, ?, ?, ?; JM4715, F, Horseshoe Bay, Magnetic Is, QLD, 10 September 1971; JM4724, M, Horseshoe Bay, Magnetic Is, QLD, 6 October 1972; Percy Island, ?, Percy Island, QLD, 1 August 1969; Tursiops, ?, Great Palm Island, QLD, 1 June 1974; Unlabelled, ?, ?, ?, ?, ***S. sahulensis:*** 208, ?, ?, ?, ?; 212, ?, ?, ?, ?; 1019, ?, ?, ?, ?; JM4701, M, Picnic Bay, Magnetic Island, QLD, 9 October 1969; JM4717, M, Horeshoe Bay, Magnetic Island, QLD, 26 October 1971; JM4728, ?, Florence Bay, Magnetic Island, QLD, 16 August 1975; JM4731, F, Pallarenda beach, Townsville, QLD, 19 January 1976; JM4737, M, Rowes bay, Townsville, QLD, 3 July 1978; JM4738, ?, Cleveland Bay, QLD, 30 July 1984; JM4746, ?, ?, ?, ?; JM4703, M, Horeshoe Bay, Magnetic Island, QLD, 4 March 1970; JM4710, M, Cleveland Bay, QLD, 3 February 1971; JM4711, M, Kissing Point, Townsville, QLD, 25 May 1971; MM1020, ?, ?, ?, ?. **Queensland Museum, Brisbane: *Tursiops* spp.:** JM1230, F, Moreton Bay, QLD, 1 December 1975; J2647, ?, Moreton Bay, QLD, 21 December 1915; J3849, ?, Burleigh Heads, QLD, 17 June 1923; J4155, ?, Townsville, QLD, 24 October 1924; JM5241, ?, Dunwich,

North Stradbroke Island, QLD, 5 June 1905; JM5411, ?, Elcho Island, NT, ?; J5653, ?, Bribie Island, QLD, 27 June 1934; J6421, ?, Point Lookout, North Stradbroke Island, QLD, 25 July 1938; JM6428, M, Ocean Beach, Moreton Island, QLD, 22 February 1987; JM6436, F, 7 km offshore from Southport, QLD, 30 November 1974; JM6568, F, Yellow Patch, Moreton Island, QLD, 8 May 1988; JM7015, ?, North of Bundaberg, QLD, 24 May 1944; JM10114, ?, Point Lookout, North Stradbroke Island, QLD, 14 August 1993; JM11375, M, Bagara Beach (Bargara?), QLD, 4 March 1996, ***S. sahulensis:*** QMJ7443, ?, Moreton Bay, QLD, 31 October 1949; QMJM1337, ?,Gold coast, QLD, 15 April 1976; QMJM2149, M, Gold coast, QLD, 29 November 1976; QMJM4377, ?, Moreton Island, QLD, 19 April 1983; QMJM5355, ?, ?, ?, ?; QMJM6434, ?, ?, ?, ?; QMJM16617, ?, Mouth of Brisbane river, QLD, 9 June 2004. **Australian Museum, Sydney: *Tursiops* spp.:** P277, ?, ?, ?, 3 October 1900; PA278, ?, ?, ?, ?; P279, ?, Port Stephens, NSW, 5 October 1900; PA280, ?, ?, ?, ?; 305, ?, Bega, NSW, 31 October 1900; 306, ?, ?, ?, 1 November 1900; 308, ?, ?, ?, 3 November 1900; S477, ?, ?, ?, 1 January 1900; S478, ?, ?, ?, 1 January 1900; P307, ?, ?, ?, 2 November 1900; S1555, ?, La Perouse, Botany Bay, Sydney, NSW, 24 March 1920; S1778, ?, Cape Cleveland, near Townville, QLD, 12 November 1904; S2097, ?, Pelsart Island, Houtman Abrolhos, WA, 7 March 1946; B10526, ?, Port Jackson, NSW, ?; B10527, ?, ?, ?, ?; M10852, ?, 2 miles S of Crowdy Head, via Taree, NSW, 2 January 1971; M10853, ?, Nowra, NSW, 30 January 1971; M12402, ?, Newport Beach, Sydney, NSW, 1 September 1971; M22838, F, Hat Head near Kempsey, 32 km S of Coffs Harbour, NSW, 25 October 1990; M22971, F, Laurieton, NSW, 19 March 1986; M33555, ?, ?, ?, 13 November 1991; M32212, ?, Black Head Beach, N of Forster, NSW, 1 March 1995; M33286, ?, ?, ?, 17 February 1991; M28255, ?, Coffs Harbour, NSW, 11 August 1992; M38699, ?, ?, ?, 23 March 2006; Unregistered, ?, ?, ?, ?, ***S. attenuata:*** M12361, M, Britaama, Malaita, Brithish Salomon Island, 1 August 1965; M12363, ?, Britaama, Malaita, Brithish Salomon Island, 1 August 1965; M12365, ?, Britaama, Malaita, Brithish Salomon Island, 1 August 1965; M12373, ?, Britaama, Malaita, Brithish Salomon Island, 1 August 1965; M12376, ?, Britaama, Malaita, Brithish Salomon Island, 1 August 1965, ***S. bredanensis*:** P302, ?, ?, ?, ?; P303, ?, ?, ?, ?; A16564, ?, ?, South Africa, ?, ***L. hosei*:** M22837, ?, Minnie waters, NSW, 1 May 1985; M34299, ?, ?, ?, ?. **Museum Victoria, Melbourne: *Tursiops* spp.:** C7799, ?, Lorne, VIC, 18 May 1967; C10357, ?, ?, ?, ?; C11271, ?, Thalia Point, Lake Victoria, VIC, ?; C23490, M, 1 km west of Lorne, VIC, 3 November 1979; C24944, F, Elwood, VIC, 23 June 1967; C24966, ?, Lakes Entrance, to east of entrance, VIC, 1 August 1979; C24987, F, Lorne, VIC, 18 May 1967; C24989, ?, Point Danger, VIC, 14 July 1979; C24990, M, Killarney Beach, VIC, 27 January 1981; C25071, ?, Stingaree Bay, VIC, 20 December 1979; C28760, ?, Sandringham-Hampton shoreline, VIC, 13 November 1992; C28972, F, San Remo, VIC, 25 November 1991; C29460, F, Sutton Rocks, Discovery Bay, VIC, 4 January 1984; C29461, F, Port Melbourne (near Princes Pier), VIC, 8 March 1984; C29462, ?, Red Bluff Beach, Port Phillip Bay, VIC, 3 January 1983; C29463, ?, McLennan Strait, VIC, 8 November 1984; C29506, F, Tideway Beach, near Sorrento, VIC, 16 April 1994; C29577, F, Safety Beach, VIC, 23 July 1985; C29578, F, Altona, VIC, 12 September 1985; C29579, F, Western Beach, Geelong, VIC, 14 October 1985; C29580, M, Murrells Beach, VIC, 17 January 1986; C29581, M, East Beach, Port Fairy, VIC, 22 February 1986; C29582, F, Hollands Landing, VIC, 8 May 1986; C29584, F, Torquay Surf Beach, near Spring Creek, VIC, 17 April 1988; C29585, M, Wild dog creek, Apollo Bay, VIC, 13 May 1990, C29586, M, Rippleside Beach, VIC, 27 July 1991; C29587, M, Kennedy Point, VIC, 1 June 1992, C29667, F, Ocean Grove, VIC, 8 January 1987; C31643, F, Bancoora Surf Beach, VIC, ?; C35965, ?, Lake Wellington, north shore, VIC, 14 December 2006; C35966, ?, Lake Wellington, north shore, VIC, 14 December 2006; C35968, ?, Lake Wellington, Poddy Bay, VIC, 4 September 2006; C35969, ?, Sunderland Bay, Surfies Point, VIC, 8 March 2006; C35984, ?, Port Fairy, South-East Beach, VIC, 26 October 2006; C35985, ?, Gippsland Lakes, Lake Wellington, Blonde Bay, VIC, 29 November 2006; C35986, ?, Bairnsdale, Mitchell R, VIC, 26 March 2006; C35987, ?, McMillan Strait, near Hollands Landing, Bairnsdale, VIC, 21 July 2006; C36750, ?, Paynesville, VIC, 29 June 1905; Unknown, ?, Point Hibbs or Jones Bay, VIC, ?, ***S. bredanensis*:** C25028, ?, Hobsons Bay, VIC, 28 October 1869, ***L. hosei*:** C24959, F, North Shore, Corio Bay, VIC, 8 January 1978; C24992, F, Corio Bay, VIC, 8 January 1978; C24993, M, Jacksons Pier, Corio Bay, VIC, 23 January 1978. **Tasmanian Museum and Art Gallery, Hobart: *Tursiops* spp.:** A198, ?, Lisdillon, TAS, 25 September 1920; A199, ?, ?, ?, 20 April 1905; A219, ?, ?, ?, 20 April 1905; A1289, ?, Ralph's Bay, TAS, 26 January 1978; A1759, ?, Marion Bay, TAS, 21 February 2003; A2425, ?, Taroona, May 2006; A2430, ?, ?, ?, ?; A2443, ?, ?, ?, ?; Unregistered 1, ?, ?, ?, ?, ***D. delphis*:** A194, ?, Tasmania, TAS, Pre 1937; A195, ?, Tasmania, TAS, Pre 1937; A196, ?, Tasmania, TAS, Pre 1937; A785, ?, Ralphs Bay, South Arm, TAS, 1 February 1967; A787, ?, Slopen main beach, Tasman Peninsula, TAS, 1 May 1967; A1293, ?, Simpsons Bay, Bruny Island, TAS, 29 May 1905; A1721, ?, West Point, TAS, 17 March 2002; A2426, ?, King Island, TAS, ?; A2447, ?, King Island, TAS, 1 June 2002; A2876, ?, Hazards Beach, Freycinet Peninsula, TAS, 18 December 2007; A2877, ?, Hazards Beach, Freycinet Peninsula, TAS, 18 December 2007; A2878, ?, Hazards Beach, Freycinet Peninsula, TAS, 18 December 2007; A2879, ?, Hazards Beach, Freycinet Peninsula, TAS, 18 December 2007; A2880, ?, Ralphs Bay, TAS, 26 December 2007; A2881, ?, Cliffton Beach, South Arm, TAS, 18 March 2008. **Queen Victoria Museum and Art Gallery, Launceston: *Tursiops* spp.:** 8, M, Hoblers Bridge, North Esk River, TAS, 7 January 1946; 19, M, Bluffy Beach, Whitemark, Flinders Island, TAS, 14 September 1974; 35, ?, Bass Strait, TAS, 1965; 1360 (syntype of *Tursiops maugeanus*), M, Cataract Gorge, Launceston, TAS, 1 October 1902; 1361, M, NW TAS, TAS, 1903; 1362, M, Bass Strait, TAS, 22 February 1902; 1365 (holotype of *Tursiops australis*), F, Hoblers Bridge, North Esk River, TAS, 11 November 1914; Not registered, ?, Eaglehawk Neck, TAS peninsula, TAS, 10 February 1981. **South Australian Museum, Adelaide:**

***Supporting Information S2.1*. (continued)**

Tursiops* spp.:** M1075, ?, Nalpa, SA, ?; M1078, ?, Meningie, SA, ?; M3268, ?, Point Pearce, SA, 1 July 1932; M3736, ?, ?, ?, ?; M5902, ?, Woods Well, SA, ?; M6038, ?, Murray Mouth, SA, 1 May 1955; M10101, F, D'Estrees Bay, Kangaroo Island, SA, 20 March 1974; M11097, F, Memory Cove, SA, 4 May 1977; M11098, F, Memory Cove, SA, 4 May 1977; M11099, F, Memory Cove, SA, 4 May 1977; M11100, F, Memory Cove, SA, 4 May 1977; M11102, M, Memory Cove, SA, 4 May 1977; M11103, F, Memory Cove, SA, 4 May 1977; M11104, M, Memory Cove, SA, 4 May 1977; M11105, F, Memory Cove, SA, 4 May 1977; M11107, M, Memory Cove, SA, 4 May 1977; M11108, M, Memory Cove, SA, 4 May 1977; M14449, ?, Snug Cove, Mouth of De Mole River Kangaroo Island, SA, April 1987; M14450, ?, Snug Cove, Mouth of De Mole River Kangaroo Island, SA, 1 April 1987; M15025, F, Kingston, Lacepede Bay, SA, 13 January 1989; M15223, ?, American River, Pelican Lagoon, Kangaroo Island, SA, 4 September 1989; M15598, M, South Beach, Port Hughes, Spencer Gulf, SA, 8 June 1989; M15820, ?, Ceduna, Great Australian Bight, SA, 13 May 1905; M16264, M, Carpenter Rocks, Southern Ocean, SA, 13 December 1989; M16392, M, Collins Beach, Hardwicke Bay, Spencer Gulf, SA, 22 June 1990; M16426, F, Stenhouse Bay, Investigator Strait, SA, 21 February 1991; M16427, F, Granite Island, Encounter Bay, Southern Ocean, SA, 21 January 1991; M16428, M, Port Broughton, Spencer Gulf, SA, ?; M16972, F, Marion Bay, Investigator Strait, SA, 9 November 1991; M18048, M, Port Lincoln, Boston Bay, Spencer Gulf, SA, 17 October 1994; M18051, F, Pelican Point, Southern Ocean, SA, 21 July 1994; M18052, M, Port Lincoln, Boston Bay, Spencer Gulf, SA, 12 February 1994; M18053, M, Port Lincoln, Boston Bay, Spencer Gulf, SA, 24 March 1994; M18055, M, Port Lincoln, Boston Bay, Spencer Gulf, SA, 1 April 1994; M18086, F, Port Lincoln, Spencer Gulf, Boston Bay, SA, 9 March 1995; M18088, F, Port Lincoln, Spencer Gulf, Boston Bay, SA, 1 March 1995; M18093, F, Port Lincoln, SA, 4 April 1995; M18095, F, Cape Donington, Spencer Gulf, Lincoln National Park, SA, 7 November 1995; M18902, M, Port Lincoln, Boston Bay, Spencer Gulf, SA, 17 June 1905; M19952, M, Mount Dutton Bay, Coffin Bay, Great Australian Bight, SA, 28 December 1996; M19953, F, Semaphore, Gulf St Vincent, SA, 9 March 1996; M19954, F, Venus Bay, Eyre Peninsula, SA, 23 April 1996; M19965, M, Port Lincoln, Boston Bay, Spencer Gulf, SA, 13 March 1996; M19968, M, Louth Bay, Spencer Gulf, SA, 8 April 1997; M19969, F, Port Germein Bay, Spencer Gulf, SA, 8 May 1997; M19973, F, Port Noarlunga, Gulf St Vincent, SA, 4 July 1997; M19974, F, Pirates Bay, Tasman Peninsula, South Pacific Ocean, TAS, 16 January 1997; M19978, M, Port Adelaide, Gulf St Vincent, SA, 27 May 1997; M19979, M, Point Longnose, Coffin Bay, Eyre Peninsula, SA, 29 March 1997; M20733, M, Wool Bay, Yorke Peninsula, Gulf St Vincent, SA, 1 December 1997; M20734, F, Christies Beach, Gulf St Vincent, SA, 16 September 1998; M20736, M, Port Adelaide, Gulf St Vincent, SA, 30 July 1998; M20737, M, Torrens Island, Barker Inlet, Gulf St Vincent, SA, 26 July 1998; M20741, M, Goolwa Beach, Encounter Bay, SA, 25 November 1999; M20744, F, Brown Beach, Eastern Cove, Kangaroo Island, SA, 23 April 1999; M20747, M, Strawbridge Point, Kangaroo Island, Investigator Strait, SA, 16 April 1999; M20874, F, Coffin Bay, Great Australian Bight, SA, 23 August 1998; M20878, F, Kingscote, Western Cove, Nepean Bay, Kangaroo Island, SA, 22 March 1999; M21022, M, Cape Martin, Southern Ocean, SA, 26 September 1999; M21235, F, Rapid Bay, Gulf St Vincent, SA, 30 August 1998; M21255, F, Murray Mouth, Encounter Bay, SA, 23 June 1999; M21282, F, Adelaide (GPO), SA, 3 December 1998; M21314, F, St Kilda, Barker Inlet, Gulf St Vincent, SA, 30 July 1998; M21326, ?, Flinders Island, Bass Strait, TAS, 1931; M22389, M, Port Adelaide (PO), SA, 28 September 2000; M22532, M, Fowlers Bay, Great Australian Bight, SA, 4 April 2002; M22549, M, Port Adelaide, Outer Harbor, Gulf St Vincent, SA, 14 March 2003; M23323, F, Adelaide, Gulf St Vincent, SA, 13 December 2003; M23325, M, Smoky Bay, Great Australian Bight, SA, 31 March 2004; M23334, M, Emu Bay, Investigator Straight, Kangaroo Island, SA, 24 September 2004; M23356, M, Port Adelaide, Port River, SA, 4 June 2005; M23361, M, Point Tinline, D'Estrees Bay, Kangaroo Island, SA, 9 April 2004; M23365, F, Glenelg (PO), SA, 28 June 2004; M23670, F, Port Adelaide (PO), SA, 24 November 2005; M24292, M, Nene Valley, SA, 10 July 2006; M24294, F, Streaky Bay (PO), SA, 5 January 2006; M24339, F, Almonta Beach, Coffin Bay, SA, 3 February 2009; M24340, F, Sellicks Beach, SA, 20 November 2005; M24722, M, American River (PO), SA, 3 October 2007; M24723, F, American River (PO), SA, 5 October 2007; M24725, F, Emu Bay (township), SA, 18 February 2008; M24726, F, Port Adelaide (PO), SA, 8 May 2008; M24893, F, Port Adelaide, Port River North Arm, Torrens Island, SA, 11 August 2009; M24896, F, Thompson Beach, SA, 6 January 2009; M25496, M, Arno Bay, SA, 26 February 2008, ***S. attenuata: M3742, ?, ?, ?, 9 April 1905; M21304, M, Malaita Island, Salomon Island, 30 August 1965; M21305, M, Malaita Island, Salomon Island, 30 August 1965; M21306, M, Malaita Island, Salomon Island, 30 August 1965, ***S. bredanensis*:** M1069, ?, ?, ?, 16 March 1905. **Natural History Museum, London:** 353.a. (holotype of *Delphinus truncatus*), Duncannon Pool, near Stoke Gabriel, River Dart, Devonshire, England, 03 July 1804; 1862.6.6.13 (syntype of *Delphinus catalania*), F, Cape Melville Island, Queensland, Australia, 05 September 1860; 1862.6.6.14 (syntype of *Delphinus catalania*), Cape Melville Island, Queensland, Australia, 09 October 1860; 1850.6.5.7 (*S. longirostris*), 1850. **Museum für Naturkunde, Berlin:** ZMB66400 (holotype of *Delphinus aduncus*), Red Sea, Insel Belhosse am Strand angespült, 13 April 1825; 5097 (*S. bredanensis*), F, Atlantic Ocean, 20 September 1874; 12009 (*S. attenuata*).

Supporting Table S2.1. Results from Games-Howell ANOVA and Tukey *post hoc* tests on 47 measurements and count data. All taxa were compared for each variable. Significantly different results between *Tursiops* spp. and other taxa are shown, where * = $P < 0.05$ and ** = $P < 0.001$.

Variable	Df	F	Games-Howell with Tukey post-hoc test
CBL	322	28.151	*S. attenuata***, S. longirostris***, S. bredanensis**, L. hosei***, D. delphis***
RL	329	21.168	*S. attenuata***, S. longirostris***, S. sahulensis***, S. bredanensis**, L. hosei***
TREN	329	11.808	*S. attenuata***, S. longirostris***, S. bredanensis**, L. hosei***
RWB	329	27.087	*S. attenuata***, S. coeruleoalba***, S. longirostris***, D. delphis***
RW60	327	42.074	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis**, S. bredanensis**, L. hosei***
RW75%	321	51.103	*S. attenuata***, S. longirostris***, S. sahulensis***, S. bredanensis***, D. delphis***
RWM	328	58.038	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis***, S. bredanensis***, D. delphis***
RW25%	327	44.810	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis***, D. delphis***
PRW	329	43.539	*S. attenuata***, S. coeruleoalba**, S. longirostris***, S. sahulensis***, L. hosei**, D. delphis***
WCB	329	7.553	*S. attenuata**, S. longirostris***, S. sahulensis***, S. bredanensis**, D. delphis***
GPRW	319	59.806	*S. attenuata***, S. longirostris***, S. sahulensis***, S. bredanensis**, D. delphis***
LSOW	319	56.752	*S. attenuata***, S. coeruleoalba**, S. longirostris***, S. sahulensis***, S. bredanensis**, D. delphis***
GWRPX	328	24.750	*S. attenuata***, S. longirostris***, S. sahulensis***, D. delphis***
GWLPX	328	24.153	*S. attenuata***, S. longirostris***, D. delphis***
GWPX	329	30.895	*S. attenuata***, S. longirostris***, S. sahulensis***, D. delphis***
WRN	305	42.467	*S. attenuata***, S. longirostris***, S. sahulensis***, S. bredanensis**, D. delphis***
HRN	305	12.257	*S. coeruleoalba**,S. longirostris***, S. bredanensis**, D. delphis*
WLN	301	59.660	*S. attenuata***, S. longirostris***, S. sahulensis***, L. hosei**, D. delphis***
HLN	301	10.849	*S. attenuata**, S. longirostris***, D. delphis***
GWEN	329	59.867	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis***, L. hosei***, D. delphis***
GWAO	327	23.551	*S.coeruleoalba***, S. sahulensis***, L. hosei***, D. delphis***
ZW	324	61.617	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis***, L. hosei**, D. delphis***
GPOW	319	64.413	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis***, D. delphis***
GPARW	325	48.039	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis**, L. hosei***, D. delphis***
LWPTF	326	61.764	*S. attenuata***, S. longirostris***, S. sahulensis***, D. delphis***
EHB	328	59.643	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis***, L. hosei**, D. delphis***
EHBHP	327	54.252	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis***, L. hosei**, D. delphis***
ILB	323	112.514	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis***, L. hosei***, D. delphis***
GLPTF	327	122.082	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis***, L. hosei***, D. delphis***
GWPTF	328	172.976	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis***, L. hosei***, D. delphis***
MAJDTF	324	121.067	*S. attenuata***, S. coeruleoalba***, S. longirostris***, L. hosei***, D. delphis***
MINDTF	320	35.473	*S. longirostris***, S. sahulensis***
LO	322	53.490	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis***, L. hosei**, D. delphis***
LAL	322	26.936	*S. attenuata***, S. coeruleoalba**, S. longirostris***, S. sahulensis***, S. bredanensis**, D. delphis***
GWIN	322	39.311	*S. attenuata***, S. longirostris***, S. sahulensis***, D. delphis***
GLPT	281	21.514	*S. coeruleoalba***, S. longirostris***, S. sahulensis***, D. delphis***
TRPS	327	19.633	*S. attenuata***, S. longirostris***, S. sahulensis***, S. bredanensis**, L. hosei***
UTLTR	329	18.387	*S. longirostris***, S. sahulensis***, S. bredanensis**, L. hosei***
ATW	305	71.179	*S. attenuata***, S. coeruleoalba***, S. longirostris***, L. hosei***, D. delphis***
WAS	326	41.381	*S. attenuata***, S. coeruleoalba**, S. longirostris***, S. sahulensis**, D. delphis***
GWPV	325	13.147	*S. attenuata***, S. longirostris***, S. sahulensis***,D. delphis***
TUL	311	156.948	*S. attenuata**, S. coeruleoalba***, S. longirostris***, S. sahulensis***, S. bredanensis***, L. hosei***,D. delphis***
TUR	311	156.854	*S. attenuata**, S. coeruleoalba***, S. longirostris***, S. sahulensis***, S. bredanensis***, L. hosei***,D. delphis***
TLL	275	85.980	*S. coeruleoalba***, S. longirostris***, L. hosei***,D. delphis***
TLR	265	16.264	*S. attenuata***, S. coeruleoalba***, S. longirostris***, D. delphis***
Tooth tot	259	848.667	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis***, S. bredanensis**, L. hosei***,D. delphis***
Tooth diameter	218	132.687	*S. attenuata***, S. coeruleoalba***, S. longirostris***, S. sahulensis**, L. hosei***,D. delphis***

Supporting Table S2.2. Two-dimensional measurements and count recorded for specimens examined in this study. The variables were measured as 1 = parallel to plane of view, 2 = parallel to feature or, 3 = perpendicular to plane. Variables described in WP=Perrin (1975), GR=Ross (1977), JYW=Wang *et al.* 2000*b*, CK=Kemper (2004) and #MJ=new measurements.

Variables	Abbreviation and measuring dimension	Reference
Condylobasal length	CBL, 1	WP, GR, JYW, CK
Rostrum length	RL, 1	WP, GR, JYW, CK
Tip of rostrum to external nares	TREN, 1	WP, GR, JYW, CK
Rostrum width at base	RWB, 3	WP, JYW, CK
Rostrum width at 60 mm from base	RW60, 3	WP, GR, CK
Rostrum width at 3/4 of rostrum length from base	RW75%, 3	WP, GR, JYW, CK
Rostrum width at mid-length	RWM, 3	WP, GR, CK
Rostrum width at 1/4 of rostrum length from base	RW25%, 3	JYW
Premaxillae width at mid-rostral length	PRW, 3	WP, GR, JYW, CK
Width of cancellous bone on maxilla at mid-rostrum	WCB, 2	CK
Apex of premaxillary to base	PAB, 1	JYW
Greatest preorbital width of skull	GPRW, 3	WP, GR, JYW, CK
Least supraorbital width	LSOW, 3	WP, JYW
Greatest width right premaxillae	GWPRX, 3	#MJ
Greatest width left premaxillae	GWLPX, 2	#MJ
Greatest width of premaxillae	GWPX, 2	WP, GR, JYW, CK
Greatest width of right nasal	WRN, 2	#MJ
Greatest height of right nasal	HRN, 2	#MJ
Greatest width of left nasal	WLN, 2	#MJ
Greatest height of left nasal	HLN, 2	#MJ
Greatest width of external nares	GWEN, 3	WP, GR, JYW, CK
Greatest width of anterior overhang of nuchal crest	GWAO, 2	CK,
Zygomatic width of skull	ZW, 3	WP, GR, JYW, CK
Greatest postorbital width of skull	GPOW, 3	WP, GR, JYW, CK
Greatest width across parietals	GPARW, 3	WP, GR, JYW, CK
Least width between posterior borders of temporal fossa	LWPTF, 3	CK,
External height of braincase	EHB, 2	GR,
External height of braincase to highest point	EHBHP, 2	#MJ
Internal length of braincase, from occipital condyles to anterior wall of cranium	ILB, 2	GR, CK,
Greatest length of left temporal fossa	GLPTF, 2	WP, GR, CK
Greatest width of left temporal fossa	GWPTF, 2	WP, GR, CK
Major diameter of (anterior) temporal fossa	MAJDTF, 2	WP, CK
Minor diameter of (anterior) temporal fossa	MINDTF, 2	WP, CK
Length of orbit	LO, 2	WP, GR, JYW, CK
Length of antorbital process of lacrimal	LAL, 2	WP, JYW, CK
Greatest width of internal nares	GWIN, 3	WP, JYW, CK
Greatest length of pterygoids	GLPT, 2	WP, JYW, CK
Tip of rostrum to medial palatine suture	TRPS, 1	#MJ
Length of upper tooth row to tip of rostrum	UTLTR, 1	WP, GR, JYW, CK
Alveolar tooth width at mid-rostrum	ATW, 2	JYW
Width of alisphenoid at suture with the basisphenoid	WAS, 3	JYW
Greatest width of posterior flange of vomer	GWPV, 3	JYW, CK
Number of teeth – upper left	TUL	WP, GR, CK
Number of teeth – upper right	TUR	WP, GR, CK
Number of teeth – lower left	TLL	WP, GR, CK
Number of teeth – lower right	TLR	WP, GR, CK
Mandible length	ML, 1	WP, GR, CK
Length of lower tooth row to tip of rostrum	LTRL, 1	WP, GR, JYW, CK
Mandible height	MH, 2	WP, GR, JYW, CK
Mandibular fossa length	MFL, 2	WP, JYW, CK
Mandibular symphysis	MS, 2	GR, CK

7.2. Chapter 3

Supporting Table S3.1. Abbreviations and their definitions used throughout text, graphs and tables in alphabetic order.

Abbreviation	Meaning
2D	two-dimensional data
3DGM	three-dimensional geometric morphometrics data
DFA	discriminant function analysis
GPA	generalised Procrustes analysis
HCA	hierarchical cluster analyses
MANOVA	multivariate analysis of variance
NSW	New South Wales
NT	Northern Territory
PCA	principal component analysis
PCs	principal components
PERMANOVA	permutational multivariate analysis of variance
QLD	Queensland
SA	South Australia
SABD	southern Australian bottlenose dolphin
TAS	Tasmania
TPS	thin-plate-spline
VIC	Victoria
WA	Western Australia

Supporting Information S3.2. Specimens examined for the study by institution and taxa (name as allocated by the institution). Data include registration number, sex, locality, state and stranding date of the specimens used for the study. Missing data = ?. Intermediate (Table 7) and *T. australis* specimens are in bold.

Western Australian Museum, Perth: M1192, ?, Swan River Estuary, WA, 26 September 1929; M1228, ?, Cape Leeuwin, WA, 11 March 1930; M2947, ?, Kukerin?, WA?, 6 August 1953; M6384, F, Shell Bch, Peron Peninsula, WA, 29 October 1964; M6395, M, Swanbourne, WA, 26 November 1964; M6845, ?, Carnarvon area, WA, 8 March 1966; M7028, ?, Yallingup, WA, ?; M7044, ?, Long Is, Houtman Abrolhos, WA, 18 May 1905; M7870, ?, Boranup, WA, 1 June 1967; M7881, ?, ?, ?, ?; M9098, ?, Rockingham, WA, 27 November 1970; M11387, ?, Barrow Island, WA, 25 May 1905; M11940, ?, Baba Head, Shark Bay, WA, 14 August 1970; M11941, ?, Nanga Bay, near Shark Bay, WA, ?; M15246, ?, Parry Inlet, WA, 1 September 1971; M15249, ?, Jurien Bay, WA, 21 January 1970; M15255, ?, Herald Bight, WA, 30 January 1977; M16293, ?, no data - John Dell's dam burial ground, WA?, ?; M26631, ?, Unknown, NT, 8 June 1905; M26633, ?, Unknown, ?, 8 June 1905; M28125, M, Unknown, NT, 1 October 1985; M28126, M, Elizabeth River, NT, 6 June 1905; M28127, F, Unknown, NT, 2 October 1985; M28131, M, Unknown, NT, 30 September 1984; M28135, M, NT, NT, 3 October 1985; M28136, M, Unknown, NT,1 October 1985; M28138, M, NT, NT, 30 September 1985; M28140, M, Unknown, NT, 11 October 1985; M28151, M, Unknown, NT,19 October 1985; M29122, ?, Garden Island, WA, 19 January 1989; M36671, ?, ?, WA, 1 September 1991; M42285, F, Nanya, Shark Bay, WA, 14 October 1992; M42286, ?, Dubaut Point, Monkey Mia, WA, 12 April 1993; M52395, ?, Monkey Mia, WA, ?; M54135, ?, Matilda Bay, Swan River, WA, 16 January 1979; M54141, F, Floreat Beach, WA, 15 September 1984; M55192, ?, Meerup Beach, WA, 6 August 1945; M60866, ?, ?, ?, ?, **intermediate 2D:** M5723, ?, Rottnest Island, WA, 10 April 1963; M7499, ?, Point Peron, WA, 29 November 1966; M7584, ?, John Point (Garden Island?), WA, 25 January 1967; M15245, ?, ?, ?, 17 May 1968; M16298, ?, Hopetoun, WA, 20 January 1983; M25813, ?, no data - skull found in collection, ?, ?, **intermediate 3DGM:** M4794, ?, Esperance, WA, 22 February 1958; M7871, ?, Manypeaks (Albany), WA, 17 December 1967. **Museum and Art Gallery of the Northern Territory, Darwin:** U0241, ?, Beach Ne. Murgenella, Australian Economic Zone (AEZ), 5 June 1985; U0513, M, Arafura Sea, AEZ, 13 August 1985; U0517, F, Arafura Sea, AEZ, 26 January 1984; U0521, F, Arafura Sea, AEZ, 14 August 1985; U0523, ?, Arafura Sea, AEZ, 21 January 1984; U0527, ?, Arafura Sea, AEZ, 3 December 1983; U0533, ?, Arafura Sea, AEZ, 13 October 1984; U0535, ?, Arafura Sea, AEZ, 1 December 1983; U0537, ?, Arafura Sea, AEZ, 1 December 1983; U0661, ?, Arafura Sea, AEZ, 10 December 1983; U0662, F, Arafura Sea, AEZ, 3 December 1983; U0665, M, Timor Sea, AEZ, 29 September 1984; U0691, ?, Arafura Sea, AEZ, 1 December 1983; U0693, ?, Arafura Sea, AEZ, 1 December 1983; U0694, F, Arafura Sea, AEZ, 9 November 1983; U0695, ?, Arafura Sea, AEZ, 13 October 1983; U3955, ?, Maria Island, NT, 27 July 1972; U3956, ?, Marchinbar Island-Cape Wessel, NT, 6 October 1972; U5095, ?, Unknown, ?, ?; U5635, ?, Bustard Island, Groote Eylandt, NT, 1 August 2006, **intermediate 2D:** U0534, ?, Arafura Sea, AEZ, 9 December 1983. **Museum of Tropical Queensland, Townsville:** MM91A, ?, Great Palm Island, QLD, 12 July 1976; MM1018, ?, ?, ?, ?; JM4715, F, Horseshoe Bay, Magnetic Is, QLD, 10 September 1971; JM4724, M, Horseshoe Bay, Magnetic Is, QLD, 6 October 1972; Percy Island, ?, ID-'*Tursiops'*, ?, Great Palm Island, QLD, 1 June 1974; Unlabelled, ?, ?, ?, ?, **intermediate 3DGM:** Percy Island, ?, Percy Island, QLD, 1 August 1969. **Queensland Museum, Brisbane:** JM1230, F, Moreton Bay, QLD, 1 December 1975; J2647, ?, Moreton Bay, QLD, 21 December 1915; J3849, ?, Burleigh Heads, QLD, 17 June 1923; J4155, ?, Townsville, QLD, 24 October 1924; JM5241, ?, Dunwich, North Stradbroke Island, QLD, 5 June 1905; JM5411, ?, Elcho Island, NT, ?; J5653, ?, Bribie Island, QLD, 27 June 1934; J6421, ?, Point Lookout, North Stradbroke Island, QLD, 25 July 1938; JM6428, M, Ocean Beach, Moreton Island, QLD, 22 February 1987; JM6436, F, 7 km offshore from Southport, QLD, 30 November 1974; JM6568, F, Yellow Patch, Moreton Island, QLD, 8 May 1988; JM11375, M, Bagara Beach (Bargara?), QLD, 4 March 1996, **intermediate 2D:** JM7015, ?, North of Bundaberg, QLD, 24 May 1944; **intermediate 3DGM:** JM10114, ?, Point Lookout, North Stradbroke Island, QLD, 14 August 1993. **Australian Museum, Sydney:** P277, ?, ?, ?, 3 October 1900; PA278, ?, ?, ?, ?; P279, ?, Port Stephens, NSW, 5 October 1900; PA280, ?, ?, ?, ?; 305, ?, Bega, NSW, 31 October 1900; 306, ?, ?, ?, 1 November 1900; 308, ?, ?, ?, 3 November 1900; S477, ?, ?, ?, 1 January 1900; S478, ?, ?, ?, 1 January 1900; P307, ?, ?, ?, 2 November 1900; S1555, ?, La Perouse, Botany Bay, Sydney, NSW, 24 March 1920; S1778, ?, Cape Cleveland, near Townville, QLD, 12 November 1904; S2097, ?, Pelsart Island, Houtman Abrolhos, WA, 7 March 1946; B10526, ?, Port Jackson, NSW, ?; B10527, ?, ?, ?, ?; M10852, ?, 2 miles S of Crowdy Head, via Taree, NSW, 2 January 1971; M10853, ?, Nowra, NSW, 30 January 1971; M12402, ?, Newport Beach, Sydney, NSW, 1 September 1971; M32212, ?, Black Head Beach, N of Forster, NSW, 1 March 1995; M33286, ?, ?, ?, 17 February 1991; M28255, ?, Coffs Harbour, NSW, 11 August 1992; M38699, ?, ?, ?, 23 March 2006, **intermediate 2D:** M22838, F, Hat Head near Kempsey, 32 km S of Coffs Harbour, NSW, 25 October 1990; Unregistered, ?, ?, NSW, ?, **intermediate 3DGM:** M22971, F, Laurieton, NSW, 19 March 1986; M33555, ?, ?, ?, 13 November 1991. **Museum Victoria, Melbourne:** C7799, ?, Lorne, VIC, 18 May 1967; C11271, ?, Thalia Point, Lake Victoria, VIC, ?; C23490, M, 1 km west of Lorne, VIC, 3 November 1979; C24966, ?, Lakes Entrance, to east of entrance, VIC, 1 August 1979; C24987, F, Lorne, VIC, 18 May 1967; C24989, ?, Point Danger, VIC, 14 July 1979; C28972, F, San Remo, VIC, 25 November 1991; C29460, F, Sutton Rocks, Discovery Bay, VIC, 4 January 1984; C29461, F, Port Melbourne (near Princes Pier), VIC, 8 March 1984; C29462, ?, Red Bluff Beach, Port Phillip Bay, VIC, 3 January 1983; C29463, ?, McLennan Strait, VIC, 8 November 1984; C29578, F, Altona, VIC, 12 September 1985; C29581, M, East Beach, Port Fairy, VIC, 22 February 1986;

C29582, F, Hollands Landing, VIC, 8 May 1986; C29584, F, Torquay Surf Beach, near Spring Creek, VIC, 17 April 1988; C29585, M, Wild dog creek, Apollo Bay, VIC, 13 May 1990; C31643, F, Bancoora Surf Beach, VIC, ?; C35969, ?, Sunderland Bay, Surfies Point, VIC, 8 March 2006; C35984, ?, Port Fairy, South-East Beach, VIC, 26 October 2006, **intermediate 2D:** C24990, M, Killarney Beach, VIC, 27 January 1981; ***T. australis*:** C10357, ?, ?, ?, ?; C24944, F, Elwood, VIC, 23 June 1967; C25071, ?, Stingaree Bay, VIC, 20 December 1979; C28760, ?, Sandringham-Hampton shoreline, VIC, 13 November 1992; C29506, F, Tideway Beach, near Sorrento, VIC, 16 April 1994; C29579, F, Western Beach, Geelong, VIC, 14 October 1985; C29580, M, Murrells Beach, VIC, 17 January 1986; C29586, M, Rippleside Beach, VIC, 27 July 1991; C29587, M, Kennedy Point, VIC, 1 June 1992, C29667, F, Ocean Grove, VIC, 8 January 1987; C35965, ?, Lake Wellington, north shore, VIC, 14 December 2006; C35966, ?, Lake Wellington, north shore, VIC, 14 December 2006; C35968, ?, Lake Wellington, Poddy Bay, VIC, 4 September 2006; C35985, ?, Gippsland Lakes, Lake Wellington, Blonde Bay, VIC, 29 November 2006; C35986, ?, Bairnsdale, Mitchell R, VIC, 26 March 2006; C35987, ?, McMillan Strait, near Hollands Landing, Bairnsdale, VIC, 21 July 2006; C36750, ?, Paynesville, VIC, 29 June 1905; Unknown, ?, Point Hibbs or Jones Bay, VIC, ?, C29577, F, Safety Beach, VIC, 23 July 1985. **Tasmanian Museum and Art Gallery, Hobart:** A198, ?, Lisdillon, TAS, 25 September 1920; A199, ?, ?, ?, 20 April 1905; A219, ?, ?, ?, 20 April 1905; A1289, ?, Ralph's Bay, TAS, 26 January 1978; A2425, ?, Taroona, May 2006; A2443, ?, ?, ?, ?; Unregistered 1, ?, ?, ?, ?, ***T. australis*:** A1759, ?, Marion Bay, TAS, 21 February 2003, A2430, ?, ?, ?, ?. **Queen Victoria Museum and Art Gallery, Launceston:** 8, M, Hoblers Bridge, North Esk River, TAS, 7 January 1946; 19, M, Bluffy Beach, Whitemark, Flinders Island, TAS, 14 September 1974; 35, ?, Bass Strait, TAS, 1965; 1360 (syntype of *Tursiops maugeanus*), M, Cataract Gorge, Launceston, TAS, 1 October 1902; 1361, M, NW TAS, TAS, 1903; 1362, M, Bass Strait, TAS, 22 February 1902; Not registered, ?, Eaglehawk Neck, TAS peninsula, TAS, 10 February 1981, ***T. australis*:** 1365 (holotype of *Tursiops australis*), F, Hoblers Bridge, North Esk River, TAS, 11 November 1914. **South Australian Museum, Adelaide:** M1075, ?, Nalpa, SA, ?; M1078, ?, Meningie, SA, ?; M3268, ?, Point Pearce, SA, 1 July 1932; M3736, ?, ?, ?, ?; M6038, ?, Murray Mouth, SA, 1 May 1955; M10101, F, D'Estrees Bay, Kangaroo Island, SA, 20 March 1974; M11097, F, Memory Cove, SA, 4 May 1977; M11098, F, Memory Cove, SA, 4 May 1977; M11099, F, Memory Cove, SA, 4 May 1977; M11100, F, Memory Cove, SA, 4 May 1977; M11102, M, Memory Cove, SA, 4 May 1977; M11103, F, Memory Cove, SA, 4 May 1977; M11104, M, Memory Cove, SA, 4 May 1977; M11105, F, Memory Cove, SA, 4 May 1977; M11107, M, Memory Cove, SA, 4 May 1977; M11108, M, Memory Cove, SA, 4 May 1977; M14449, ?, Snug Cove, Mouth of De Mole River Kangaroo Island, SA, April 1987; M14450, ?, Snug Cove, Mouth of De Mole River Kangaroo Island, SA, 1 April 1987; M15025, F, Kingston, Lacepede Bay, SA, 13 January 1989; M15223, ?, American River, Pelican Lagoon, Kangaroo Island, SA, 4 September 1989; M15598, M, South Beach, Port Hughes, Spencer Gulf, SA, 8 June 1989; M15820, ?, Ceduna, Great Australian Bight, SA, 13 May 1905; M16264, M, Carpenter Rocks, Southern Ocean, SA, 13 December 1989; M16392, M, Collins Beach, Hardwicke Bay, Spencer Gulf, SA, 22 June 1990; M16426, F, Stenhouse Bay, Investigator Strait, SA, 21 February 1991; M16427, F, Granite Island, Encounter Bay, Southern Ocean, SA, 21 January 1991; M16428, M, Port Broughton, Spencer Gulf, SA, ?; M16972, F, Marion Bay, Investigator Strait, SA, 9 November 1991; M18048, M, Port Lincoln, Boston Bay, Spencer Gulf, SA, 17 October 1994; M18051, F, Pelican Point, Southern Ocean, SA, 21 July 1994; M18052, M, Port Lincoln, Boston Bay, Spencer Gulf, SA, 12 February 1994; M18053, M, Port Lincoln, Boston Bay, Spencer Gulf, SA, 24 March 1994; M18055, M, Port Lincoln, Boston Bay, Spencer Gulf, SA, 1 April 1994; M18086, F, Port Lincoln, Spencer Gulf, Boston Bay, SA, 9 March 1995; M18088, F, Port Lincoln, Spencer Gulf, Boston Bay, SA, 1 March 1995; M18093, F, Port Lincoln, SA, 4 April 1995; M18095, F, Cape Donington, Spencer Gulf, Lincoln National Park, SA, 7 November 1995; M18902, M, Port Lincoln, Boston Bay, Spencer Gulf, SA, 17 June 1905; M19952, M, Mount Dutton Bay, Coffin Bay, Great Australian Bight, SA, 28 December 1996; M19953, F, Semaphore, Gulf St Vincent, SA, 9 March 1996; M19954, F, Venus Bay, Eyre Peninsula, SA, 23 April 1996; M19965, M, Port Lincoln, Boston Bay, Spencer Gulf, SA, 13 March 1996; M19968, M, Louth Bay, Spencer Gulf, SA, 8 April 1997; M19969, F, Port Germein Bay, Spencer Gulf, SA, 8 May 1997; M19973, F, Port Noarlunga, Gulf St Vincent, SA, 4 July 1997; M19974, F, Pirates Bay, Tasman Peninsula, South Pacific Ocean, TAS, 16 January 1997; M19978, M, Port Adelaide, Gulf St Vincent, SA, 27 May 1997; M19979, M, Point Longnose, Coffin Bay, Eyre Peninsula, SA, 29 March 1997; M20733, M, Wool Bay, Yorke Peninsula, Gulf St Vincent, SA, 1 December 1997; M20734, F, Christies Beach, Gulf St Vincent, SA, 16 September 1998; M20736, M, Port Adelaide, Gulf St Vincent, SA, 30 July 1998; M20737, M, Torrens Island, Barker Inlet, Gulf St Vincent, SA, 26 July 1998; M20741, M, Goolwa Beach, Encounter Bay, SA, 25 November 1999; M20744, F, Brown Beach, Eastern Cove, Kangaroo Island, SA, 23 April 1999; M20747, M, Strawbridge Point, Kangaroo Island, Investigator Strait, SA, 16 April 1999; M20874, F, Coffin Bay, Great Australian Bight, SA, 23 August 1998; M20878, F, Kingscote, Western Cove, Nepean Bay, Kangaroo Island, SA, 22 March 1999; M21022, M, Cape Martin, Southern Ocean, SA, 26 September 1999; M21235, F, Rapid Bay, Gulf St Vincent, SA, 30 August 1998; M21255, F, Murray Mouth, Encounter Bay, SA, 23 June 1999; M21282, F, Adelaide (GPO), SA, 3 December 1998; M21314, F, St Kilda, Barker Inlet, Gulf St Vincent, SA, 30 July 1998; M21326, ?, Flinders Island, Bass Strait, TAS, 1931; M22389, M, Port Adelaide (PO), SA, 28 September 2000; M22532, M, Fowlers Bay, Great Australian Bight, SA, 4 April 2002; M22549, M, Port Adelaide, Outer Harbor, Gulf St Vincent, SA, 14 March 2003; M23323, F, Adelaide, Gulf St Vincent, SA, 13 December 2003; M23325, M, Smoky Bay, Great Australian Bight, SA, 31 March 2004; M23334, M, Emu

Bay, Investigator Straight, Kangaroo Island, SA, 24 September 2004; M23356, M, Port Adelaide, Port River, SA, 4 June 2005; M23361, M, Point Tinline, D'Estrees Bay, Kangaroo Island, SA, 9 April 2004; M23365, F, Glenelg (PO), SA, 28 June 2004; M23670, F, Port Adelaide (PO), SA, 24 November 2005; M24292, M, Nene Valley, SA, 10 July 2006; M24294, F, Streaky Bay (PO), SA, 5 January 2006; M24339, F, Almonta Beach, Coffin Bay, SA, 3 February 2009; M24340, F, Sellicks Beach, SA, 20 November 2005; M24722, M, American River (PO), SA, 3 October 2007; M24723, F, American River (PO), SA, 5 October 2007; M24725, F, Emu Bay (township), SA, 18 February 2008; M24726, F, Port Adelaide (PO), SA, 8 May 2008; M24893, F, Port Adelaide, Port River North Arm, Torrens Island, SA, 11 August 2009; M24896, F, Thompson Beach, SA, 6 January 2009; M25496, M, Arno Bay, SA, 26 February 2008, **intermediate 2D:** M5902, ?, Woods Well, SA, ?. **Natural History Museum, London:** 353.a. (holotype of *Delphinus truncatus*), Duncannon Pool, near Stoke Gabriel, River Dart, Devonshire, England, 03 July 1804; 1862.6.6.13 (syntype of *Delphinus catalania*), F, Cape Melville Island, Queensland, Australia, 05 September 1860; 1862.6.6.14 (syntype of *Delphinus catalania*), Cape Melville Island, Queensland, Australia, 09 October 1860. **Museum für Naturkunde, Berlin:** ZMB66400 (holotype of *Delphinus aduncus*), Red Sea, Insel Belhosse am Strand angespült, 13 April 1825.

Supporting Table S3.3. Two-dimensional skull measurements and counts for specimens examined in this study. Variables were measured as 1 = parallel to plane of view, 2 = parallel to feature or, 3 = perpendicular to plane. Variables described in WP = Perrin (1975), GR = Ross (1977), JYW = Wang et al. (2000b), CK = Kemper (2004), TK = Kasuya (1973) and #MJ = new measurements.

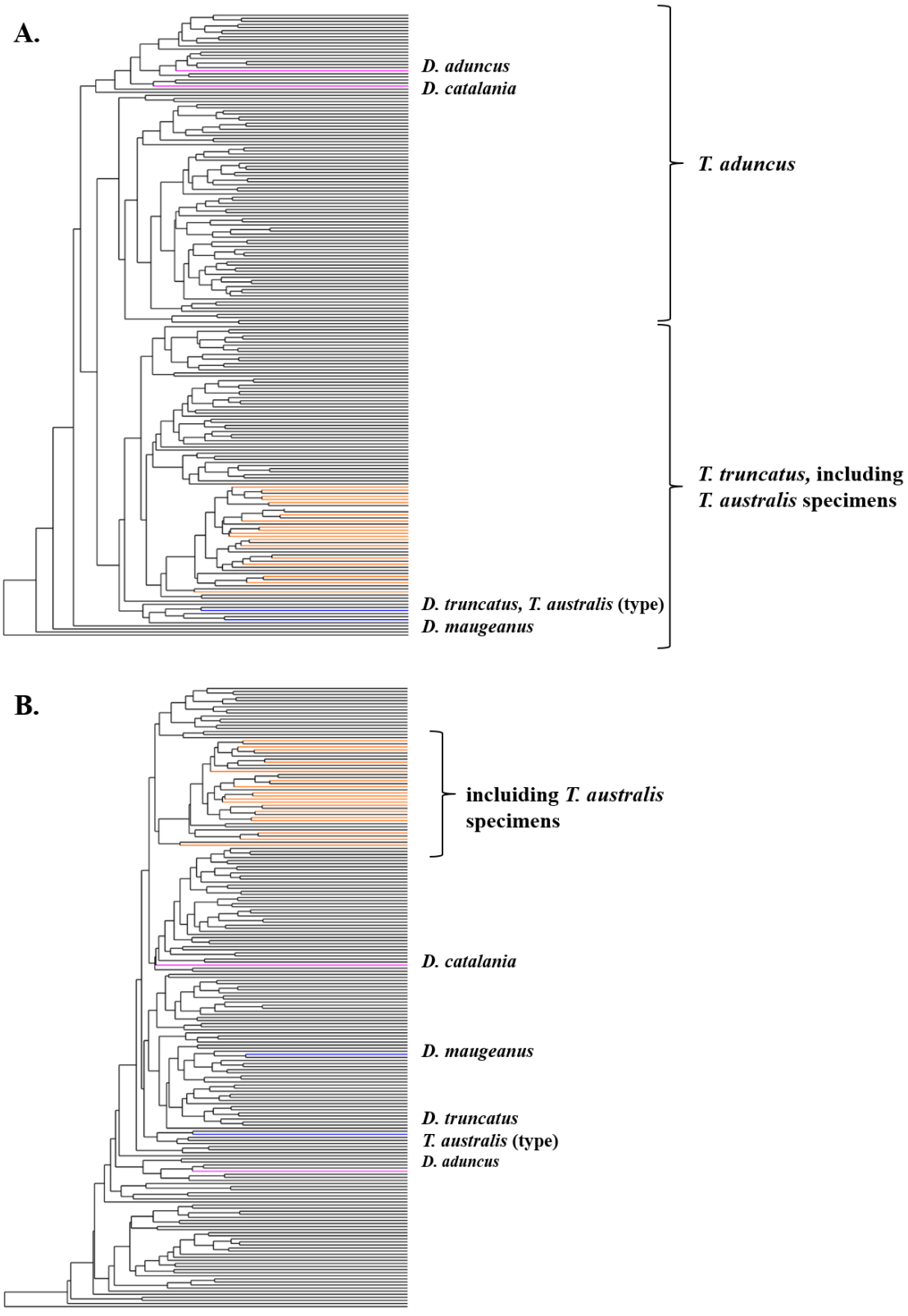
Variables	Abbreviation	Reference
Condylobasal length	CBL, 1	WP, GR, JYW, CK
Rostrum length	RL, 1	WP, GR, JYW, CK
Tip of rostrum to external nares	TREN, 1	WP, GR, JYW, CK
Rostrum width at base	RWB, 3	WP, JYW, CK
Rostrum width at 60 mm from base	RW60, 3	WP, GR, CK
Rostrum width at 3/4 of rostrum length from base	RW75%, 3	WP, GR, JYW, CK
Rostrum width at mid-length	RWM, 3	WP, GR, CK
Rostrum width at 1/4 of rostrum length from base	RW25%, 3	JYW
Premaxillae width at mid-rostral length	PRW, 3	WP, GR, JYW, CK
Width of cancellous bone on maxilla at mid-rostrum	WCB, 2	CK
Apex of premaxillary convexity to base	PAB, 1	JYW
Greatest preorbital width of skull	GPRW, 3	WP, GR, JYW, CK
Least supraorbital width	LSOW, 3	WP, JYW
Greatest width right premaxillae	GWPRX, 3	#MJ
Greatest width left premaxillae	GWLPX, 2	#MJ
Greatest width of premaxillae	GWPX, 2	WP, GR, JYW, CK
Greatest width of right nasal	WRN, 2	#MJ
Greatest height of right nasal	HRN, 2	#MJ
Greatest width of left nasal	WLN, 2	#MJ
Greatest height of left nasal	HLN, 2	#MJ
Greatest width of external nares	GWEN, 3	WP, GR, JYW, CK
Greatest width of anterior overhang of nuchal crest	GWAO, 2	CK
Zygomatic width of skull	ZW, 3	WP, GR, JYW, CK
Greatest postorbital width of skull	GPOW, 3	WP, GR, JYW, CK
Greatest width across parietals	GPARW, 3	WP, GR, JYW, CK
Least width between posterior borders of temporal fossa	LWPTF, 3	CK
External height of braincase	EHB, 2	GR
External height of braincase to highest point	EHBHP, 2	#MJ
Internal length of braincase, from occipital condyles to anterior wall of cranium	ILB, 2	GR, CK
Greatest length of left temporal fossa	GLPTF, 2	WP, GR, CK
Greatest width of left temporal fossa	GWPTF, 2	WP, GR, CK
Major diameter of (anterior) temporal fossa	MAJDTF, 2	WP, CK
Minor diameter of (anterior) temporal fossa	MINDTF, 2	WP, CK
Length of orbit	LO, 2	WP, GR, JYW, CK
Length of antorbital process of lacrimal	LAL, 2	WP, JYW, CK
Greatest width of internal nares	GWIN, 3	WP, JYW, CK
Greatest length of pterygoids	GLPT, 2	WP, JYW, CK
Tip of rostrum to medial palatine suture	TRPS, 1	#MJ
Length of upper tooth row to tip of rostrum	UTLTR, 1	WP, GR, JYW, CK
Alveolar tooth width at mid-rostrum	ATW, 2	JYW
Width of alisphenoid at suture with the basisphenoid	WAS, 3	JYW
Greatest width of posterior flange of the vomer	GWPV, 3	JYW, CK
Mandible length	ML, 1	WP, GR, CK
Length of lower tooth row to tip of rostrum	LTRL, 1	WP, GR, JYW, CK
Mandible height	MH, 2	WP, GR, JYW, CK
Mandibular symphysis length	MSL, 1	CK
Mandibular fossa length	MFL, 2	WP, JYW, CK
Antero-posterior diameter of cochlear portion of periotic	APDC, 1	TK
Length of tympanic bulla	LT, 1	TK, GR, CK
Anterior tip to end of inner posterior prominence	ATEIP, 1	TK
Width of tympanic bulla	WT, 3	TK
Width across inner and outer posterior prominence of bulla	WIOP, 3	TK
Tooth diameter	TD	CK

Supporting Table S3.4. Categorical skull and tooth data, and vertebral counts used in this study. Variables described in CK = Kemper (2004) and KCR = Charlton-Robb et al. (2011).

Data	Codes	Reference
Bone resorption to frontal and pterygoids (possibly parasite-related)	1 = none, 2 = slight, 3 = moderate erosion, 4 = extensive erosion	CK
Extent of the nuchal crest	0 mm = none, 1−5 mm = Slight, 6−10 mm = moderate, >10 mm = large	CK
Temporal fossa shape (length/width)	1 = oval, 2 = round	CK
Highest point of skull	1 = nuchal crest, 2 = interparietal of vertex, 3 = frontal, 4 = nasal	CK
Pterygoid hamular ridge shape	1 = no ridge, 2 = slight ridge or ridge just at anterior end, 3 = distinct ridge all along the pterygoid	CK
Pterygoid convexity (in anterior view)	1 = flat, 2 = slight to moderate, 3 = very arched	CK
Arch of premaxilla along the rostrum	1 = flat, 2 = slight to moderate, 3 = very arched	CK
Position of lower tip of pterygoid *vs.* top maxilla suture	1 = suture lower than pterygoid tip, 2 = suture and pterygoid tip same height, 3 = suture higher than pterygoid tip	KCR
Pterygoid/maxilla suture	1 = maxilla suture closer to tip of rostrum compare to the pterygoid tip, 2 = same distance, 3 = suture further away from tip of rostrum compare to the pterygoid tip	KCR
Palatine shape	1 = even triangle shape, 2 = skewed triangle shape, 3 = prolonged triangle shape	KCR
Comparison of pterygoid and palatine length	1 = pterygoid longer, 2 = palatine longer, 3 = pterygoid and palatine same length	KCR
Tooth counts	TUL = number of teeth upper left, TUR = number of teeth upper right, TLL = number of teeth lower left, TLR = number of teeth lower right	CK
Vertebral counts	CV = cervical, TV = thoracic, XV = lumbar, YV = anterior caudal, Z = posterior caudal, TOTV = total vertebrae, VPVF = number of first vertebra with perforating vertical foramen	CK

*Supporting Table S3.5.*Three-dimensional landmarks for *Tursiops* spp. specimens examined in this study.

Landmark	Definition
1−2	Tip of rostrum left and right side
3−4	Rostrum width at 3/4 from base on left and right side
5−6	Rostrum width at mid-length from base on left and right side
7−8	Rostrum width at 1/4 from base on left and right side
9−10	Rostrum width at narrowing on left and right side
11 and 14	Preorbital point on left and right side
12−13	Rostrum base on left and right side
15−16	Greatest preorbital width of cranium on left and right side
17−18	External nares lower on left and right side
19−20	Greatest width of external nares on left and right side
21−22	Highest point of nasal on left and right side
23 and 27	Corner of crest left and right side
24 and 26	Halfway point between landmarks 23−35 and 25−27 respectively measured on nuchal crest
25	Midpoint of nuchal crest
28	Mid-length between opening upper and midpoint of crest
29 and 33	Greatest postorbital width of cranium on left and right side
30 and 34	Zygomatic width of cranium on left and right side
31 and 35	Greatest width between temporal fossa on left and right side
32 and 36	Least width between posterior border of temporal fossa on left and right side
37 and 41	Greatest width of left occipital condyles on left and right side
38 and 40	Greatest width opening left and right side
39 and 42	Greatest height upper left and right side
43	Greatest height of cranium
44 and 53	Apex of premaxilla on left and right side
45 and 52	Mid-length orbit on left and right side
46 and 50	Greatest height of temporal fossa upper on left and right side
47 and 51	Greatest height of temporal fossa lower on left and right side
48−49	Greatest length of cranium at the occipital condyles on left and right side
54	Medial palatine suture
55−56	Mid-length on pterygoid crests on right and left side
57 and 59	Tip of pterygoids on left and right side
58	Pterygoid angle
60−61	Greatest width of internal nares on left and right side
62 and 66	Width of alisphenoid at suture with the basisphenoid on left and right side
63 and 65	Mid-length between alisphenoid at suture and basisphenoid on left and right side
64	Midpoint of basisphenoid
67 and 71	Highest point of basioccipital on left and right side
68 and 70	Mid-length between midpoint and highest point of basioccipital on left and right side
69	Midpoint basioccipital
72−73	Highest point paraoccipital



Supporting Fig. S3.6. Hierarchical cluster analysis results (UPGMA) for three-dimensional geometric morphometric, including all Australian *Tursiops* spp. and type specimens. A = size-uncorrected shape data, and B = size-corrected shape data (all PCs except PC1). *Tursiops australis* specimens (Charlton-Robb *et al.* 2011) highlighted in orange.

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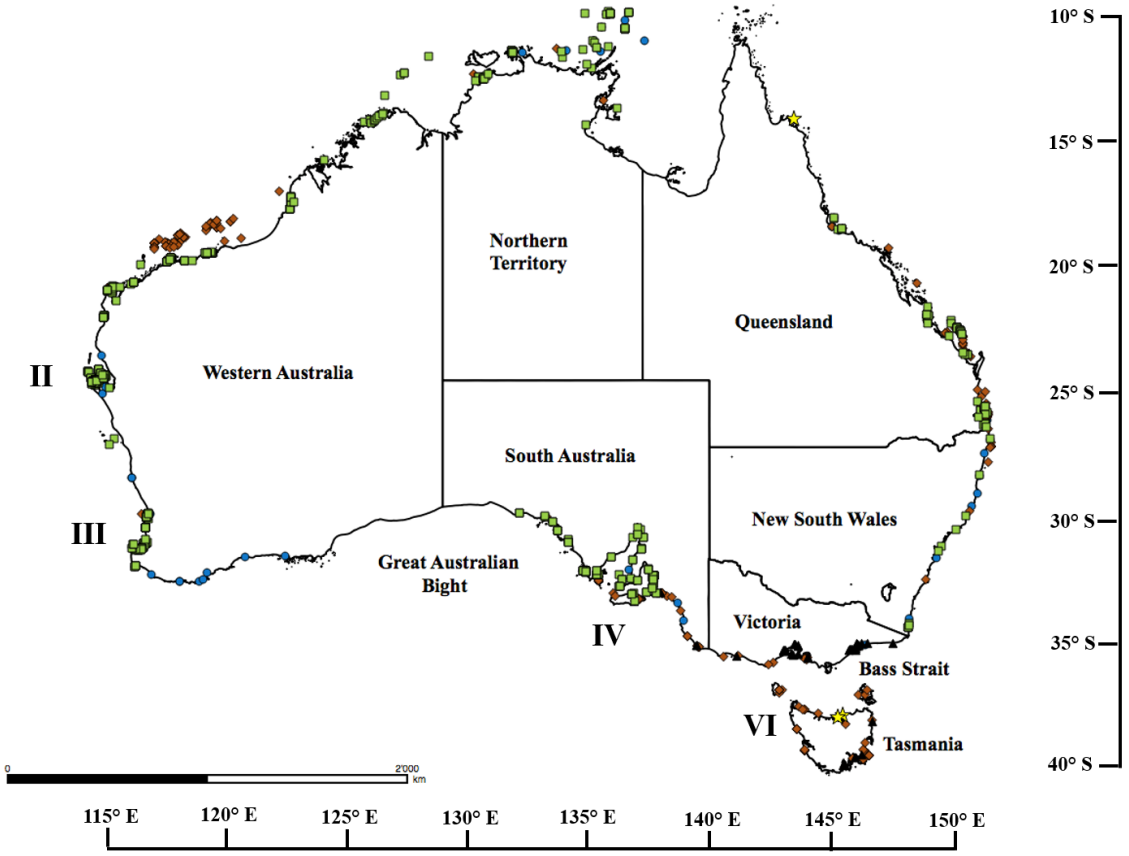


Supporting Fig. S4.1. Location of the soft tissue and bone/teeth samples of *Tursiops* spp. used in the study. Green squares = *T. aduncus*, brown diamonds = *T. truncatus*, blue circles = unknown species identification, black triangle = *T. australis*, and yellow stars = type specimens. Genetic groupings II, III, IV and VI (as defined in Table 2) are shown. Genetic groupings I and V are not shown; I = *T. aduncus* found in eastern and western coasts of Australia and V = *T. truncatus* found in all sampling locations.

Supporting Table S4.2. Soft tissue samples of *Tursiops* analysed in the study. Specimens are sorted by sampling location and state/territory. Data include registration ID, locality, state/territory, latitude, longitude, sampling date and sex. Missing data = ?. QLD = Queensland, NSW = New South Wales, VIC = Victoria, TAS = Tasmania, SA = South Australia, SWA = southern Western Australia, CWA = central Western Australia, NWA = northern Western Australia, and NT = Northern Territory.

ID	Locality	State/ territory	Latitude	Longitude	Sampling date	Sex
14110	Mooloolaba	QLD	-26.7362	153.2545	12/06/2004	F
14114	Elliot Head, Queensland	QLD	-24.8506	152.5217	16/06/2004	F
14117	East of Hook Island	QLD	-20.0684	149.0431	8/09/2004	F
14118	Outside Gladstone Harbour, outer leads	QLD	-23.8214	151.6905	14/10/2004	F
14120	Outside Gladstone Harbour, outer leads	QLD	-23.8214	151.6905	14/10/2004	F
14122	on route Lady Musgrave Island to Bundaberg	QLD	-23.9857	152.3766	3/11/2004	M
14124	on route Lady Musgrave Island to Bundaberg	QLD	-23.9858	152.3677	3/11/2004	F
14125	on route Lady Musgrave Island to Bundaberg	QLD	-24.0336	152.3848	3/11/2004	F
14126	on route Lady Musgrave Island to Bundaberg	QLD	-24.0676	152.3871	3/11/2004	F
14127	on route Lady Musgrave Island to Bundaberg	QLD	-24.0676	152.3871	3/11/2004	F
14128	on route Lady Musgrave Island to Bundaberg	QLD	-24.0676	152.3871	3/11/2004	F
14129	on route Lady Musgrave Island to Bundaberg	QLD	-24.0676	152.3871	3/11/2004	M
14130	on route Lady Musgrave Island to Bundaberg	QLD	-24.0676	152.3871	3/11/2004	F
14132	on route Lady Musgrave Island to Bundaberg	QLD	-24.2892	152.3871	3/11/2004	F
14133	on route from Bundaberg to Sandy Straits	QLD	-24.8333	152.6207	6/11/2004	F
14134	on route from Bundaberg to Sandy Straits	QLD	-24.8333	152.6207	6/11/2004	F
14146	QLD	QLD	?	?	26/06/1905	M
14151	Stradbroke Is	QLD	-27.6667	153.502	19/07/2005	M
14152	Stradbroke Is	QLD	-27.6667	153.502	19/07/2005	M
14153	Stradbroke Is	QLD	-27.5717	153.5197	19/07/2005	M
14154	Stradbroke Is	QLD	-27.5379	153.5383	19/07/2005	M
14155	Abeam Coolum	QLD	-26.5	153.3914	19/07/2005	F
14157	Nth Burnett Heads	QLD	-24.6717	152.4923	26/07/2005	M
14159	Sth Lady Musgrave	QLD	-24.4237	152.4053	26/07/2005	F
14160	Sth Lady Musgrave	QLD	-24.3696	152.4021	26/07/2005	F
14161	Sth Lady Musgrave	QLD	-24.3696	152.4021	26/07/2005	F
14162	Sth Lady Musgrave	QLD	-24.3696	152.4021	26/07/2005	F
14163	Sth Lady Musgrave	QLD	-24.1927	152.3861	26/07/2005	F
14176	NW Boult Reef	QLD	-23.7503	152.2598	28/09/2005	F
14178	6nm W Fitzroy Reef	QLD	-23.6507	152.0537	5/10/2005	F
14179	Gladstone Channel approach	QLD	-23.8546	151.6214	5/10/2005	F
14180	Gladstone Harbour approach	QLD	-23.8677	151.6013	5/10/2005	F
14181	Hervey Bay 1st mark	QLD	-24.9192	152.757	29/10/2005	M
14340	Pearl Bay Queensland	QLD	-22.4362	150.7378	20/09/2011	M
14341	Keppel Bay QLD	QLD	-23.1693	150.7881	11/09/2011	F
14343	Pearl Bay Queensland	QLD	-22.4205	150.7018	20/09/2011	M
14363	Withsundays Island GBR	QLD	-20.3878	148.9247	5/08/2011	M
23000	Cleveland Bay	QLD	-19.1966	146.793	16/07/2007	F
23001	Cleveland Bay	QLD	-19.2094	146.948	23/08/2007	F
23002	Cleveland Bay	QLD	-19.1645	146.9424	3/07/2008	M
23003	Cleveland Bay	QLD	-19.1582	146.9407	3/07/2008	F

***Supporting Table S4.2*. (continued)**

23005	Moreton Bay	QLD	-27.2106	153.3646	21/03/2008	M
23006	Moreton Bay	QLD	-27.2283	153.358	21/03/2008	M
23007	Moreton Bay	QLD	-27.4686	153.3526	25/03/2008	M
23008	Moreton Bay	QLD	-27.2008	153.3573	26/03/2008	M
23009	Moreton Bay	QLD	-27.2014	153.3566	26/03/2008	M
23010	Moreton Bay	QLD	-27.2027	153.3588	26/03/2008	M
23011	Moreton Bay	QLD	-27.3068	153.39	26/03/2008	F
23012	Moreton Bay	QLD	-27.1813	153.3664	27/03/2008	F
23013	Moreton Bay	QLD	-27.1817	153.3667	27/03/2008	F
23014	Moreton Bay	QLD	-27.3716	153.3591	29/03/2008	M
23015	Moreton Bay	QLD	-27.3463	153.1951	2/04/2008	F
23016	Moreton Bay	QLD	-27.3466	153.2014	2/04/2008	F
23017	Moreton Bay	QLD	-27.2441	153.3639	1/05/2008	M
23018	Moreton Bay	QLD	-27.2479	153.3625	1/05/2008	M
23019	Moreton Bay	QLD	-27.2508	153.3669	1/05/2008	M
23020	Moreton Bay	QLD	-27.2489	153.37	1/05/2008	M
23021	Moreton Bay	QLD	-27.2635	153.3659	1/05/2008	M
23022	Moreton Bay	QLD	-27.2861	153.3903	1/05/2008	F
23023	Moreton Bay	QLD	-27.946	153.427	10/10/1995	F
23024	Noosa	QLD	-26.398	153.062	30/08/1996	M
23025	Moreton Bay	QLD	-27.904	153.412	22/11/1997	F
23026	Moreton Bay	QLD	-27.417	153.517	5/12/1997	M
23027	Moreton Bay	QLD	-27.797	153.416	21/04/1998	F
23028	Great Palm Island, Halifax Bay	QLD	-18.738	146.618	11/05/1998	M
23029	Moreton Bay	QLD	-27.946	153.427	27/06/1998	F
23030	Moreton Bay	QLD	-27.998	153.334	23/04/1999	F
23031	Moreton Bay	QLD	-27.946	153.427	17/06/1999	F
23032	Moreton Bay	QLD	-27.946	153.427	15/11/1999	F
23033	Moreton Bay	QLD	-26.95	153.067	5/08/2004	M
23034	Moreton Bay	QLD	-27.2191	153.3628	20/03/2008	F
23273	Whitsundays	QLD	-20.2622	148.9526	4/06/2010	F
23274	Whitsundays	QLD	-20.2828	148.9197	4/06/2010	M
23558	Keppel Bay	QLD	-23.2351	150.8362	16/08/2010	F
23559	Keppel Bay	QLD	-23.2351	150.8362	19/08/2010	F
23560	Keppel Bay	QLD	-23.2286	150.9683	24/08/2010	M
23561	Keppel Bay	QLD	-23.0393	150.7791	28/08/2010	F
23562	Keppel Bay	QLD	-23.4188	150.838	18/09/2010	F
23564	Keppel Bay	QLD	-23.0732	150.8542	18/09/2010	M
23565	Keppel Bay	QLD	-23.0725	150.855	29/09/2010	M
23566	Keppel Bay	QLD	-23.0342	150.7791	29/09/2010	M
23567	Bunker Group GBR	QLD	-23.7552	152.287	22/10/2010	F
23568	Bunker Group GBR	QLD	-23.287	151.858	17/10/2010	M
23569	Bunker Group GBR	QLD	-23.4521	151.8862	18/10/2010	F
23570	Bunker Group GBR	QLD	-23.6197	152.137	17/10/2010	M
23571	Bunker Group GBR	QLD	-23.6197	152.137	14/10/2010	M

***Supporting Table S4.2*. (continued)**

23572	Bunker Group GBR	QLD	-23.6401	152.1207	22/10/2010	F
23573	Bunker Group GBR	QLD	-23.653	152.1554	18/10/2010	M
23575	Bunker Group GBR	QLD	-23.7524	152.2547	17/10/2010	F
23576	Bunker Group GBR	QLD	-23.7524	152.2547	17/10/2010	F
23577	Bunker Group GBR	QLD	-23.7524	152.2547	17/10/2010	M
23578	Bunker Group GBR	QLD	-23.7853	152.2887	17/10/2010	F
23579	Bunker Group GBR	QLD	-23.8223	152.3198	16/10/2010	M
23580	Keppel Bay	QLD	-23.9042	152.3704	16/08/2010	F
23581	Keppel Bay	QLD	-23.9042	152.3704	16/10/2010	F
23582	Port Clinton	QLD	-22.6711	150.8187	15/09/2008	F
14109	north of Southport	NSW	-29.6703	153.5217	12/06/2004	F
14135	North NSW	NSW	-28.7894	153.674	12/11/2004	F
14136	North NSW	NSW	-28.9717	153.674	12/11/2004	F
14137	North NSW	NSW	-28.9717	153.674	12/11/2004	F
14138	North NSW	NSW	-28.9717	153.674	12/11/2004	F
14139	North NSW	NSW	-28.9717	153.674	12/11/2004	F
14140	North NSW	NSW	-28.9717	153.674	12/11/2004	M
14141	North NSW	NSW	-28.9717	153.674	12/11/2004	M
14142	North NSW	NSW	-28.9717	153.674	12/11/2004	M
14143	North NSW	NSW	-29.009	153.6257	12/11/2004	F
14148	NSW	NSW	-36.9016	149.9634	21/03/2002	F
14149	Nth Coffs Harbour	NSW	-30.2501	153.1423	14/07/2005	M
14673	Twofold Bay	NSW	-37.0909	149.9199	?	M
14674	Twofold Bay	NSW	-37.0909	149.9199	?	F
14675	Twofold Bay	NSW	-37.0909	149.9199	?	M
23252	1.5 km N of Byron Bay	NSW	-28.637	153.6175	7/08/1991	F
23257	NSW	NSW	?	?	?	F
23269	Sydney	NSW	-14.1153	126.2439	?	F
23271	NSW	NSW	-13.9661	126.3647	?	F
23533	southern Port Phillip Bay	VIC	-38.3014	144.6694	29/11/2001	F
23535	Lake Tyres	VIC	-37.822	148.1044	18/07/2004	M
23536	Altona	VIC	-37.8553	144.8521	2/10/2004	F
23537	Kennett River	VIC	-38.6676	143.8553	28/04/2005	F
23538	Lady Bay	VIC	-37.9173	147.7031	9/04/2005	?
23539	Lake Victoria	VIC	-37.9696	147.6221	6/07/2005	M
23540	Geelong	VIC	-38.137	144.372	19/09/2005	F
23541	Plover Point	VIC	-38.0873	147.4055	4/12/2006	M
23542	Blonde Bay	VIC	-38.0873	147.4055	1/12/2006	M
23543	Lake Wellington 1km	VIC	-38.0873	147.4055	14/12/2006	M
23544	Point Hicks	VIC	-37.8006	149.2673	18/06/2007	M
23545	Loch Sport	VIC	-38.0515	147.5722	11/01/2004	F
23546	Poddy Bay Tucker Point	VIC	-38.1201	147.5697	25/10/2007	M
23547	Jones Bay	VIC	-37.8712	147.6725	29/10/2007	F
23548	Paynesville	VIC	-37.9179	147.7186	4/11/2007	M

***Supporting Table S4.2*. (continued)**

23549	Killarney	VIC	-38.3531	142.3041	22/01/2008	F
23550	Point Henry - geelong	VIC	-38.1199	144.4198	23/01/2008	M
23551	Swan Reach	VIC	-37.8174	147.8538	2/11/2008	M
23552	Apollo bay	VIC	-38.7668	143.6672	22/02/2009	F
23210	Pirates Bay	TAS	-43.0167	147.9333	16/01/1997	F
23211	Pirates Bay	TAS	-43.0167	147.9333	16/01/1997	M
23446	Point Hibbs	TAS	-42.6221	145.2709	25/11/2003	F
23447	Point Hibbs	TAS	-42.6221	145.2709	25/11/2003	M
23448	Point Hibbs	TAS	-42.6221	145.2709	25/11/2003	F
23449	Point Hibbs	TAS	-42.6221	145.2709	25/11/2003	F
23450	Point Hibbs	TAS	-42.6221	145.2709	25/11/2003	F
23451	Point Hibbs	TAS	-42.6221	145.2709	25/11/2003	F
23452	Point Hibbs	TAS	-42.6221	145.2709	25/11/2003	M
23453	Point Hibbs	TAS	-42.6221	145.2709	25/11/2003	F
23454	Point Hibbs	TAS	-42.6221	145.2709	25/11/2003	F
23455	Point Hibbs	TAS	-42.6221	145.2709	25/11/2003	F
23456	Near the blowhole, Naracoopa Beach, King Island	TAS	-39.921	144.121	28/11/2004	M
23457	Near the blowhole, Naracoopa Beach, King Island	TAS	-39.921	144.121	28/11/2004	F
23458	Near the blowhole, Naracoopa Beach, King Island	TAS	-39.921	144.121	28/11/2004	F
23459	Near the blowhole, Naracoopa Beach, King Island	TAS	-39.921	144.121	28/11/2004	F
23460	Near the blowhole, Naracoopa Beach, King Island	TAS	-39.921	144.121	28/11/2004	M
23461	Near the blowhole, Naracoopa Beach, King Island	TAS	-39.921	144.121	28/11/2004	M
23462	Near the blowhole, Naracoopa Beach, King Island	TAS	-39.921	144.121	28/11/2004	M
23463	Dover, Tassal Dover - fish farm	TAS	-43.3135	147.0153	15/05/2000	M
23464	Deep Bay, Huon Aquaculture, Deep Bay	TAS	-43.242	147.0547	26/10/2003	M
23465	Huon Aquaculture - Fish Farm (Police Point Road)	TAS	-43.2867	147.0985	25/11/2001	F
23466	Maurouard Beach, St Helens	TAS	-41.3174	148.317	8/08/2005	F
23467	Rheban Beach	TAS	-42.6504	147.9575	8/01/2006	F
23468	Point Hibbs	TAS	-42.6221	145.2709	25/11/2003	F
23469	Naracoopa Beach, King Island	TAS	-42.8269	148.1953	3/03/2009	M
23470	Naracoopa Beach, King Island	TAS	-42.8269	148.1953	3/03/2009	F
23471	Point Hibbs	TAS	-42.6221	145.2709	25/11/2003	F
23472	Humbug Point	TAS	-41.2745	148.3085	12/02/2008	F
23473	Cremorne, Pipe Clay Lagoon	TAS	-42.9699	147.5241	15/06/2011	F
23474	Stanley	TAS	-40.7639	145.2951	1/01/2011	F
23475	Stanley	TAS	-40.7639	145.2951	1/01/2011	F
23476	Fortescue Bay	TAS	-40.1337	147.6983	10/03/2011	F
23477	Orford	TAS	-42.5861	147.9072	25/01/2010	F
23492	Offshore Maria Island, East Coast Tasmania	TAS	-42.8269	148.1953	12/11/2004	M
23493	Offshore Maria Island, East Coast Tasmania	TAS	-42.8269	148.1953	12/11/2004	F
23494	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F
23495	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F
23496	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	M
23497	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F
23498	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F

***Supporting Table S4.2*. (continued)**

23499	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F
23500	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F
23501	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F
23502	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F
23503	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F
23504	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	M
23505	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F
23506	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F
23507	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F
23508	Pieman Heads Beach, West Coast Tasmania	TAS	-41.66	144.92	12/04/2010	F
23040	Coffin Bay (PO)	SA	-34.5055	135.3	8/11/2000	M
23050	Cape Banks	SA	-37.9697	140.4863	20/05/2001	M
23059	Wangary (township)	SA	-34.5338	135.4217	8/05/2001	M
23061	Coffin Bay (township)	SA	-34.6006	135.4032	18/05/2001	M
23066	Fowlers Bay (township)	SA	-31.972	132.4357	4/04/2002	M
23072	Salt Creek	SA	-36.3333	139.7167	13/11/2002	M
23074	Port Adelaide (GPO)	SA	-34.7697	138.4712	14/03/2003	M
23075	Coffin Bay (township)	SA	-34.5333	135.3697	23/10/2002	F
23080	Kingscote	SA	-35.5667	137.6	15/02/2001	F
23081	Adelaide (GPO)	SA	-34.9363	138.4883	13/10/2003	F
23085	Smoky Bay	SA	-32.3674	133.9334	31/03/2004	M
23086	Denial Bay (jetty)	SA	-32.1191	133.5833	17/12/2003	M
23091	Emu Bay (jetty)	SA	-35.5881	137.504	24/09/2004	M
23092	Point Tinline	SA	-35.9035	137.6167	9/04/2004	M
23093	Coffin Bay (PO)	SA	-34.5881	135.4008	9/05/2004	F
23094	Coffin Bay (PO)	SA	-34.5187	135.351	7/02/2004	F
23095	Coffin Bay (PO)	SA	-34.6057	135.4554	4/02/2004	M
23096	Horse Peninsula	SA	-34.5667	135.4	13/01/2004	F
23097	Venus Bay (PO)	SA	-33.2378	134.6697	9/06/2004	M
23112	Coffin Bay	SA	-34.5868	135.453	2/12/2004	M
23113	Coffin Bay (PO)	SA	-34.6222	135.4378	20/04/2005	F
23115	Aldinga (PO)	SA	-35.3028	138.4378	17/12/2005	F?
23116	Sellicks Beach	SA	-35.3296	138.4487	20/11/2005	F
23117	Parham (township)	SA	-34.45	138.253	29/01/2006	M
23119	Streaky Bay	SA	-32.7525	134.1871	?	F
23120	Coffin Bay	SA	-34.5881	135.4008	?	F
23121	Coffin Bay	SA	-34.5881	135.4008	?	M
23122	Red Cliff Point	SA	-32.7209	137.9007	1/05/2006	M?
23123	Hardwicke Bay (township)	SA	-34.8858	137.452	3/07/2006	F
23124	Nene Valley	SA	-37.9863	140.5167	10/07/2006	M
23126	Port Broughton (township)	SA	-33.5514	137.9367	28/07/2006	F
23130	Whyalla	SA	-33.0667	137.55	14/09/2006	M
23131	Point Lowly (lighthouse)	SA	-32.9047	137.7711	2/11/2006	M
23132	Streaky Bay (PO)	SA	-32.7525	134.1871	5/01/2006	F

***Supporting Table S4.2*. (continued)**

23134	Port Kenny (PO)	SA	-33.1555	134.6682	3/01/2007	M
23137	Cowell (township)	SA	-34.7167	136.95	7/04/2007	F
23145	American River (PO)	SA	-35.8034	137.7711	3/10/2007	M
23146	American River (PO)	SA	-35.8	137.8183	5/10/2007	F
23147	Port Augusta (PO)	SA	-32.6217	137.755	7/05/2008	F
23148	Arno Bay	SA	-33.9167	136.5833	26/02/2008	M
23152	Emu Bay (township)	SA	-35.5871	137.5028	18/02/2008	F
23158	Thompson Beach	SA	-34.4846	138.2712	6/01/2009	F
23160	Carpenter Rocks	SA	-37.9333	140.4363	13/12/1989	M
23161	Port Broughton	SA	-33.6	137.9333	?	M
23162	Port Hughes	SA	-34.0833	137.55	8/06/1989	M
23163	Murray Mouth	SA	-35.553	138.8833	19/10/1990	F
23165	Corny Point	SA	-34.9197	137.0833	22/06/1990	M
23166	Victor Harbor	SA	-35.555	138.6217	21/01/1991	F?
23167	Marion Bay	SA	-35.25	136.9667	9/11/1991	F
23168	Stenhouse Bay	SA	-35.2697	136.95	21/02/1991	F
23170	Port Lincoln (PO)	SA	-34.7197	135.9167	17/01/1992	M
23172	Denial Bay	SA	-32.103	133.5833	1/02/1993	M
23174	Pelican Point	SA	-34.7873	138.4833	23/06/1993	M
23175	Port Lincoln (PO)	SA	-34.7333	135.9197	19/01/1994	M
23176	Pelican Point	SA	-37.9197	140.4197	21/07/1994	F
23178	Port Lincoln (PO)	SA	-34.7333	135.9197	12/02/1994	M
23180	Port Lincoln (PO)	SA	-34.7333	135.9197	24/03/1994	M
23183	Port Lincoln (PO)	SA	-34.7333	135.9197	01/041994	M
23185	Port Lincoln (PO)	SA	-34.7333	135.9197	17/06/1905	M
23196	Cape Donington	SA	-34.7333	136	7/11/1995	F
23198	Port Lincoln	SA	-34.7333	135.9197	1/03/1995	F
23199	Port Lincoln	SA	-34.7333	135.9197	9/03/1995	F
23201	Port Lincoln	SA	-34.7333	135.9197	4/04/1995	F?
23203	Semaphore	SA	-34.8333	138.45	9/03/1996	F
23204	Venus Bay (township)	SA	-33.2542	134.6717	23/04/1996	F?
23206	Streaky Bay (township)	SA	-32.7667	134.1833	18/01/1996	M
23207	Port Lincoln (PO)	SA	-34.7167	135.905	13/03/1996	M
23209	Mount Dutton	SA	-34.5333	135.4333	28/12/1996	M
23212	Port Adelaide (PO)	SA	-34.8167	138.4848	27/05/1997	M
23213	Point Longnose	SA	-34.5333	135.3	29/03/1997	M
23214	Louth Bay	SA	-34.55	135.9333	8/04/1997	M?
23215	Point Longnose	SA	-34.5333	135.3	29/03/1997	M?
23216	Port Noarlunga (PO)	SA	-35.205	138.4717	4/07/1997	F
23218	Wool Bay	SA	-35.001	137.751	1/12/1997	F?
23219	Port Germein	SA	-33.0535	138.0207	8/05/1997	F?
23221	Port Adelaide (PO)	SA	-34.7858	138.5343	26/07/1998	M
23222	St Kilda	SA	-34.75	138.5333	30/07/1998	F
23223	Port Adelaide (GPO)	SA	-34.8202	138.4833	30/07/1998	M
23226	Rapid Bay	SA	-35.5197	138.1833	30/08/1998	F

***Supporting Table S4.2*. (continued)**

23227	Christies Beach	SA	-35.1333	138.4667	16/09/1998	F
23233	Coffin Bay (PO)	SA	-34.6052	135.4549	23/08/1998	F
23237	Kingscote (PO)	SA	-35.7343	137.5873	22/03/1999	F
23241	American River	SA	-35.7838	137.7717	16/04/1999	M
23242	American River	SA	-35.8	137.85	23/04/1999	F
23244	Goolwa	SA	-35.55	138.8667	23/06/1999	F
23253	Cape Martin	SA	-37.4871	140.004	26/09/1999	M
23254	Goolwa (PO)	SA	-35.5212	138.7863	25/11/1999	M
23256	Port Lincoln (PO)	SA	-34.7333	135.9197	17/10/1994	M
236	Perth	SWA	-31.9953	115.7437	16/07/1998	M
237	Perth	SWA	-31.9988	115.7382	16/07/1998	F
238	Perth	SWA	-32.0104	115.7396	16/07/1998	F
14500	Bunbury	SWA	-33.2949	115.696	7/10/2006	F
14501	Bunbury	SWA	-33.2958	115.6848	7/10/2006	M
14503	Bunbury	SWA	-33.2615	115.7088	8/10/2006	F
14504	Bunbury	SWA	-33.2957	115.6977	8/10/2006	F
14505	Bunbury	SWA	-33.3014	115.6088	8/10/2006	F
14506	Bunbury	SWA	-33.3322	115.5315	8/10/2006	M
14507	Bunbury	SWA	-33.3333	115.5343	9/10/2006	F
14508	Bunbury	SWA	-33.3256	115.5365	9/10/2006	F
14509	Bunbury	SWA	-33.5057	115.5113	9/10/2006	M
14510	Bunbury	SWA	-33.5018	115.5193	9/10/2006	M
14511	Bunbury	SWA	-33.5004	115.5217	9/10/2006	F
14512	Bunbury	SWA	-33.4937	115.5277	9/10/2006	F
14515	Bunbury	SWA	-33.3025	115.6404	9/10/2006	M
14516	Bunbury	SWA	-33.3335	115.6222	9/10/2006	M
14517	Bunbury	SWA	-33.4009	115.5952	9/10/2006	M
14518	Bunbury	SWA	-33.1537	115.6466	9/10/2006	M
14555	Busselton	SWA	-33.6231	115.3382	11/10/2007	F
14556	Busselton	SWA	-33.6088	115.1796	11/10/2007	M
14558	Busselton	SWA	-33.5523	115.4766	12/10/2007	F
14560	Busselton	SWA	-33.5269	115.4956	12/10/2007	M
14563	Busselton	SWA	-33.551	115.4643	12/10/2007	F
14567	Busselton	SWA	-33.6356	115.315	30/10/2007	F
14568	Busselton	SWA	-33.6303	115.3125	30/10/2007	M
14571	Busselton	SWA	-33.6405	115.2921	30/10/2007	F
14573	Cockburn Sound	SWA	-32.1538	115.6775	5/11/2007	M
14574	Cockburn Sound	SWA	-32.1682	115.6939	5/11/2007	M
14576	Cockburn Sound	SWA	-32.0964	115.6876	7/11/2007	M
14577	Cockburn Sound	SWA	-32.2013	115.7499	8/11/2007	M
14578	Cockburn Sound	SWA	-32.1383	115.6934	8/11/2007	M
14579	Cockburn Sound	SWA	-32.1367	115.697	8/11/2007	M
14581	Cockburn Sound	SWA	-32.1359	115.6973	9/11/2007	F
14582	Cockburn Sound	SWA	-32.1362	115.6956	9/11/2007	F

***Supporting Table S4.2*. (continued)**

14590	Busselton	SWA	-33.6197	115.4062	22/11/2007	M
14592	Busselton	SWA	-33.5798	115.4493	22/11/2007	F
14595	Busselton	SWA	-33.5958	115.2036	22/11/2007	M
14596	Busselton	SWA	-33.5278	115.0399	22/11/2007	M
14597	Busselton	SWA	-33.5262	115.0344	22/11/2007	M
14598	Augusta	SWA	-34.323	115.191	1/06/2008	F
14599	Augusta	SWA	-34.3436	115.1728	1/06/2008	F
14600	Augusta	SWA	-34.3553	115.1687	1/06/2008	F
14601	Augusta	SWA	-34.3624	115.1664	1/06/2008	F
14604	Augusta	SWA	-34.3392	115.1803	2/06/2008	M
14605	Mandurah	SWA	-32.5998	115.6296	13/07/2008	F
14608	Mandurah	SWA	-32.6013	115.6233	13/07/2008	M
14610	Mandurah	SWA	-32.6061	115.6225	13/07/2008	M
14611	Mandurah	SWA	-32.6054	115.6235	13/07/2008	F
14612	Mandurah	SWA	-32.6051	115.623	13/07/2008	F
14613	Mandurah	SWA	-32.6082	115.62	13/07/2008	M
14615	Mandurah	SWA	-32.6046	115.6202	13/07/2008	F
14616	Mandurah	SWA	-32.6027	115.6218	13/07/2008	F
14617	Mandurah	SWA	-32.6023	115.6227	13/07/2008	M
14620	Busselton	SWA	-33.3593	115.0681	26/07/2008	M
14622	Busselton	SWA	-33.3772	115.1064	26/07/2008	F
14019	Geraldton	SWA	-28.7859	114.3688	?	F
14020	Geraldton	SWA	-28.6361	114.2365	?	F
14021	Geraldton	SWA	-28.3202	114.0852	?	F
168	ESB	CWA	-25.7759	113.7006	20/05/1998	F
213	ESB	CWA	-25.732	113.6774	19/06/1998	F
216	UI	CWA	-26.2007	113.3319	22/06/1998	M
219	UI	CWA	-26.2007	113.3319	22/06/1998	F
221	UI	CWA	-26.2007	113.3319	23/06/1998	F
224	ESB	CWA	-25.7419	113.704	6/07/1998	M
226	ESB	CWA	-25.7404	113.7025	6/07/1998	M
242	ESB	CWA	-25.7702	113.7981	19/07/1998	F
262	ESB	CWA	-25.7391	113.7297	3/08/1998	F
281	ESB	CWA	-25.7214	113.6604	10/08/1998	M
289	DH	CWA	-25.5843	113.0308	17/08/1998	F
290	DH	CWA	-25.5843	113.0308	17/08/1998	F
291	DH	CWA	-25.6251	113.056	17/08/1998	M
293	DH	CWA	-25.6185	113.0654	17/08/1998	F
294	DH	CWA	-25.6185	113.0654	17/08/1998	F
295	DH	CWA	-25.885	113.1581	18/08/1998	F
296	DH	CWA	-25.885	113.1581	18/08/1998	M
311	ESB	CWA	-25.5353	113.5294	21/06/1905	M
340	ESB	CWA	-25.7889	113.8805	21/06/1905	F
350	UL	CWA	-26.1023	113.4219	21/06/1905	M
352	UL	CWA	-26.1023	113.4219	21/06/1905	F

***Supporting Table S4.2*. (continued)**

357	UI	CWA	-26.0087	113.3203	21/06/1905	M
359	UI	CWA	-26.0079	113.3617	21/06/1905	M
360	UI	CWA	-26.0079	113.3617	21/06/1905	M
362	UI	CWA	-26.0804	113.3574	21/06/1905	F
363	UI	CWA	-26.0661	113.3496	21/06/1905	F
366	UI	CWA	-26.0077	113.3212	21/06/1905	M
367	UI	CWA	-26.0138	113.3245	21/06/1905	M
368	UI	CWA	-26.0106	113.3253	21/06/1905	F
369	UI	CWA	-26.0106	113.3253	21/06/1905	F
370	UL	CWA	-26.1278	113.4312	21/06/1905	F
374	UI	CWA	-26.0985	113.3572	21/06/1905	M
380	ESB	CWA	-25.5038	113.5161	21/06/1905	F
383	ESB	CWA	-25.4924	113.513	21/06/1905	M
385	ESB	CWA	-25.5507	113.536	21/06/1905	F
439	ESB	CWA	-25.5154	113.5237	17/08/2003	M
459	ESB	CWA	-25.7778	113.8409	28/07/2004	F
511	ESB	CWA	-25.8081	113.7513	8/10/2004	F
513	ESB	CWA	-25.6686	113.6248	10/10/2004	M
514	ESB	CWA	-25.6602	113.6116	10/10/2004	M
544	ESB	CWA	-25.6697	113.5975	27/10/2004	M
545	ESB	CWA	-25.7823	113.768	28/10/2004	F
546	ESB	CWA	-25.7811	113.7818	28/10/2004	M
611	UL	CWA	-26.0759	113.4123	30/06/2007	M
612	BS	CWA	-26.1391	113.2307	5/07/2007	F
613	BS	CWA	-26.1391	113.2307	5/07/2007	F
617	UL	CWA	-26.1043	113.5079	8/07/2007	F
619	UL	CWA	-26.0532	113.4241	11/07/2007	M
620	UL	CWA	-26.0614	113.454	11/07/2007	F
622	UL	CWA	-26.0416	113.4614	17/07/2007	F
631	UL	CWA	-25.994	113.3519	28/07/2007	M
635	UL	CWA	-25.9982	113.3582	29/07/2007	F
640	UL	CWA	-26.0637	113.4011	4/08/2007	M
641	UL	CWA	-26.0913	113.4164	5/08/2007	F
645	UL	CWA	-26.0023	113.3725	16/08/2007	F
649	UL	CWA	-25.9937	113.369	20/08/2007	M
653	UL	CWA	-26.032	113.4345	23/08/2007	F
656	UI	CWA	-25.9972	113.346	27/08/2007	M
657	UI	CWA	-25.9972	113.346	27/08/2007	F
658	UI	CWA	-25.9972	113.346	27/08/2007	M
659	UI	CWA	-25.9972	113.346	27/08/2007	M
660	UI	CWA	-25.9972	113.346	27/08/2007	M
661	UI	CWA	-25.9972	113.346	27/08/2007	M
665	UL	CWA	-26.0061	113.4042	2/09/2007	M
670	UL	CWA	-25.9907	113.3721	3/09/2007	M

***Supporting Table S4.2*. (continued)**

672	UL	CWA	-25.9673	113.382	3/09/2007	F
673	UL	CWA	-25.9775	113.3622	3/09/2007	M
674	UI	CWA	-26.0909	113.3411	4/09/2007	F
676	BS	CWA	-26.0064	113.2419	4/09/2007	M
677	BS	CWA	-26.0064	113.2419	4/09/2007	F
678	BS	CWA	-26.0064	113.2419	4/09/2007	F
679	BS	CWA	-26.0526	113.2284	4/09/2007	M
680	BS	CWA	-26.0526	113.2284	4/09/2007	M
681	BS	CWA	-26.0526	113.2284	4/09/2007	M
682	BS	CWA	-26.0526	113.2284	4/09/2007	F
683	BS	CWA	-26.0526	113.2284	4/09/2007	M
684	UL	CWA	-26.0367	113.413	7/09/2007	M
14147	North of Broome	NWA	-17.4974	121.6571	26/06/1905	?
14184	Pilbara	NWA	-19.7556	119.1861	16/10/2005	M
14185	Pilbara	NWA	-19.6182	119.9523	16/10/2005	M
14186	Pilbara	NWA	-18.9176	118.5862	6/02/2006	F
14187	Pilbara	NWA	-19.5564	117.4355	9/02/2006	F
14625	Pilbara	NWA	-19.1433	118.3883	19/10/2008	M
14626	Pilbara	NWA	-19.1683	118.3917	19/10/2008	M
14627	Pilbara	NWA	-19.1683	118.3917	19/10/2008	M
14628	Pilbara	NWA	-19.1317	118.825	20/10/2008	M
14629	Pilbara	NWA	-19.1317	118.825	20/10/2008	M
14630	Pilbara	NWA	-19.1317	118.825	20/10/2008	M
14631	Pilbara	NWA	-19.1317	118.825	20/10/2008	M
14633	Pilbara	NWA	-18.9467	118.84	22/10/2008	M
14634	Pilbara	NWA	-18.9567	118.5367	23/10/2008	M
14635	Pilbara	NWA	-18.9567	118.5367	23/10/2008	F
14636	Pilbara	NWA	-19.6483	117.1467	24/10/2008	M
14637	Pilbara	NWA	-19.6483	117.1467	24/10/2008	M
14638	Pilbara	NWA	-19.555	117.2467	24/10/2008	M
14639	Pilbara	NWA	-19.555	117.2467	24/10/2008	F
14640	Pilbara	NWA	-19.7217	117.2183	24/10/2008	M
14641	Pilbara	NWA	-19.8067	116.9617	26/10/2008	M
14642	Pilbara	NWA	-19.8067	116.9617	26/10/2008	M
14643	Pilbara	NWA	-19.915	117.08	26/10/2008	M
14644	Pilbara	NWA	-19.915	117.08	26/10/2008	M
14646	Pilbara	NWA	-19.5783	117.3517	30/10/2008	M
14648	Pilbara	NWA	-19.5783	117.3517	30/10/2008	M
14649	Pilbara	NWA	-19.5783	117.3517	30/10/2008	M
14650	Pilbara	NWA	-19.5783	117.3517	30/10/2008	M
14651	Pilbara	NWA	-19.5783	117.3517	30/10/2008	M
14653	Pilbara	NWA	-19.5783	117.3517	30/10/2008	M
14654	Pilbara	NWA	-19.4933	117.0617	30/10/2008	M
14655	Pilbara	NWA	-19.4933	117.0617	30/10/2008	M
14656	Pilbara	NWA	-19.81	116.65	31/10/2008	M

***Supporting Table S4.2*. (continued)**

14657	Pilbara	NWA	-19.81	116.65	31/10/2008	M
14659	Pilbara	NWA	-19.7783	116.5367	31/10/2008	M
14662	Pilbara	NWA	-19.78	116.505	1/11/2008	M
14663	Pilbara	NWA	-19.855	116.6883	1/11/2008	M
14665	Pilbara	NWA	-19.81	116.8133	1/11/2008	M
14666	Pilbara	NWA	-19.7683	116.9267	2/11/2008	F
14667	Pilbara	NWA	-19.395	117.23	2/11/2008	M
14668	Pilbara	NWA	-19.395	117.23	2/11/2008	F
14669	Pilbara	NWA	-19.4517	117.1617	2/11/2008	F
14670	Pilbara	NWA	-19.4517	117.1617	2/11/2008	F
14671	Pilbara	NWA	-19.675	116.2533	23/11/2008	F
14677	Pilbara	NWA	-19.855	116.6883	26/10/2008	M
14678	Pilbara 'offshore'	NWA	-19.8423	116.0717	27/03/2009	M
14679	Pilbara 'offshore'	NWA	-19.8187	116.009	27/03/2009	F
14681	Pilbara 'offshore'	NWA	-19.8187	116.009	27/03/2009	M
14682	Pilbara 'offshore'	NWA	-19.8187	116.009	27/03/2009	M
14683	Pilbara 'offshore'	NWA	-19.8187	116.009	27/03/2009	M
14687	Pilbara 'offshore'	NWA	-19.9883	116.0413	27/03/2009	F
14689	Pilbara 'offshore'	NWA	-19.9883	116.0413	27/03/2009	M
14691	Pilbara 'offshore'	NWA	-19.9883	116.0413	27/03/2009	F
14693	Pilbara 'offshore'	NWA	-19.9883	116.0413	27/03/2009	M
14694	Pilbara 'offshore'	NWA	-19.9883	116.0413	27/03/2009	M
14695	Pilbara 'offshore'	NWA	-19.9883	116.0413	27/03/2009	F
14696	Pilbara 'offshore'	NWA	-19.9883	116.0413	27/03/2009	M
14697	Pilbara 'offshore'	NWA	-19.9883	116.0413	27/03/2009	M
14698	Pilbara 'offshore'	NWA	-19.9883	116.0413	27/03/2009	F
14699	Pilbara 'offshore'	NWA	-19.9687	116.757	28/03/2009	F
14700	Pilbara 'offshore'	NWA	-19.9717	116.55	28/03/2009	M
14701	Pilbara 'offshore'	NWA	-19.9717	116.55	28/03/2009	F
14702	Pilbara 'offshore'	NWA	-19.9717	116.55	28/03/2009	F
14703	Pilbara 'offshore'	NWA	-20.0697	116.7257	29/03/2009	M
14704	Pilbara 'offshore'	NWA	-20.009	116.8893	29/03/2009	F
14705	Pilbara 'offshore'	NWA	-19.2747	118.3747	30/03/2009	M
14707	Pilbara 'offshore'	NWA	-19.105	118.3667	30/03/2009	M
14708	Pilbara 'offshore'	NWA	-18.9833	118.7167	31/03/2009	M
14709	Pilbara 'offshore'	NWA	-18.8167	118.8167	31/03/2009	M
14711	Pilbara 'offshore'	NWA	-18.8333	118.8167	31/03/2009	F
14713	Pilbara 'offshore'	NWA	-18.8667	119.4667	1/04/2009	M
14714	Pilbara 'offshore'	NWA	-18.8667	119.4667	1/04/2009	F
14715	Pilbara 'offshore'	NWA	-18.75	119.5833	1/04/2009	F
14716	Pilbara 'offshore'	NWA	-19.1667	119.0067	15/02/2009	F
14717	Exmouth	NWA	-21.9903	114.1423	25/03/2009	M
14718	Exmouth	NWA	-21.9903	114.1423	25/03/2009	M
14719	Exmouth	NWA	-21.9903	114.1423	25/03/2009	M

***Supporting Table S4.2*. (continued)**

14720	Exmouth	NWA	-22.0247	114.1363	25/03/2009	F
14721	Exmouth	NWA	-22.0247	114.1363	25/03/2009	F
14723	Pilbara 'offshore'	NWA	-20.104	116.0177	27/03/2009	M
14724	Coral Bay	NWA	-23.1095	113.7709	3/04/2010	F
14725	Coral Bay	NWA	-23.091	113.8046	3/04/2010	M
14726	Coral Bay	NWA	-23.0839	113.7976	3/04/2010	M
14728	Exmouth	NWA	-21.7893	114.1823	5/04/2010	M
14729	Exmouth	NWA	-21.7807	114.1639	5/04/2010	F
14730	Exmouth	NWA	-21.8055	114.1962	5/04/2010	M
14731	Coral Bay	NWA	-23.0946	113.793	6/04/2010	F
14732	Coral Bay	NWA	-23.0763	113.7937	6/04/2010	F
14733	Coral Bay	NWA	-23.1027	113.7607	6/04/2010	M
14734	Exmouth	NWA	-21.9253	113.9475	8/04/2010	M
14735	Exmouth	NWA	-21.9287	113.9453	8/04/2010	M
14736	Exmouth	NWA	-21.9807	113.927	8/04/2010	F
14737	Exmouth	NWA	-21.9809	113.9268	8/04/2010	F
14738	Exmouth	NWA	-21.9213	113.9629	8/04/2010	F
14739	Exmouth	NWA	-21.9212	113.9668	8/04/2010	M
14741	Exmouth	NWA	-22.0558	114.1211	10/04/2010	F
14742	Exmouth	NWA	-21.7907	114.1734	11/04/2010	F
14743	Exmouth	NWA	-21.7907	114.1734	11/04/2010	F
14744	Exmouth	NWA	-21.8375	114.1768	12/04/2010	M
14745	Exmouth	NWA	-21.8375	114.1768	12/04/2010	F
14746	Exmouth	NWA	-21.8208	114.1985	12/04/2010	M
14747	Exmouth	NWA	-21.7916	114.1359	12/04/2010	M
14748	Exmouth	NWA	-21.7863	114.1728	12/04/2010	M
14749	Exmouth	NWA	-21.8102	114.1902	16/04/2010	M
14750	Exmouth	NWA	-21.807	114.187	16/04/2010	M
14751	Exmouth	NWA	-21.7789	114.1583	17/04/2010	M
14752	Exmouth	NWA	-21.9664	114.1484	18/04/2010	F
14753	Exmouth	NWA	-22.4125	114.2956	18/04/2010	M
14754	Exmouth	NWA	-21.8206	114.1912	19/04/2010	F
14755	Exmouth	NWA	-21.9087	114.1521	21/04/2010	F
14756	Exmouth	NWA	-21.7967	114.1831	21/04/2010	F
14757	Exmouth	NWA	-21.9532	113.9323	23/04/2010	M
14758	Exmouth	NWA	-21.9483	113.9351	23/04/2010	M
14759	Exmouth	NWA	-21.8263	114.5006	24/04/2010	M
14760	Coral Bay	NWA	-23.1873	113.7281	29/04/2010	F
14761	Coral Bay	NWA	-23.1873	113.7281	29/04/2010	M
14762	Coral Bay	NWA	-23.1873	113.7281	29/04/2010	F
14763	Coral Bay	NWA	-23.1873	113.7281	29/04/2010	M
14764	Onslow	NWA	-21.6701	114.9821	1/05/2010	F
14765	Onslow	NWA	-21.6055	115.0883	1/05/2010	F
14766	Onslow	NWA	-21.6055	115.0883	1/05/2010	M
14767	Onslow	NWA	-21.6055	115.0883	1/05/2010	M

***Supporting Table S4.2*. (continued)**

14768	Onslow	NWA	-21.5959	115.0974	1/05/2010	F
14769	Onslow	NWA	-21.5959	115.0974	1/05/2010	F
14770	Dampier	NWA	-20.6351	116.6442	8/05/2010	M
14771	Dampier	NWA	-20.6317	116.655	8/05/2010	F
14773	Dampier	NWA	-20.5783	116.6667	10/05/2010	F
14774	Dampier	NWA	-20.5223	116.8024	10/05/2010	F
14775	Dampier	NWA	-20.5223	116.8024	10/05/2010	F
14776	Dampier	NWA	-20.5223	116.8024	10/05/2010	M
14777	Dampier	NWA	-20.5223	116.8024	10/05/2010	F
14778	Dampier	NWA	-20.6855	116.5782	13/05/2010	F
14779	Dampier	NWA	-20.6855	116.5782	13/05/2010	F
14780	Dampier	NWA	-20.6855	116.5782	13/05/2010	F
14781	Dampier	NWA	-20.6855	116.5782	13/05/2010	F
14782	Dampier	NWA	-20.6823	116.5771	14/05/2010	M
14783	Dampier	NWA	-20.6823	116.5771	14/05/2010	M
14784	Dampier	NWA	-20.6823	116.5771	14/05/2010	M
14785	Dampier	NWA	-20.6823	116.5771	14/05/2010	M
14786	Dampier	NWA	-20.6823	116.5771	14/05/2010	M
14787	Dampier	NWA	-20.6226	117.4065	19/05/2010	M
14788	Dampier	NWA	-20.6226	117.4066	19/05/2010	F
14789	Dampier	NWA	-20.6226	117.4066	19/05/2010	M
14790	Dampier	NWA	-20.4952	116.7911	21/05/2010	M
14791	Dampier	NWA	-20.4952	116.7911	21/05/2010	M
14792	Dampier	NWA	-20.4952	116.7911	21/05/2010	F
14793	Dampier	NWA	-20.4952	116.7911	21/05/2010	M
14795	Dampier	NWA	-20.4952	116.7911	21/05/2010	F
14796	Dampier	NWA	-20.5828	116.746	1/06/2010	F
14797	Dampier	NWA	-20.5828	116.746	1/06/2010	F
14798	Port Hedland	NWA	-20.2624	118.6325	16/06/2010	M
14799	Port Hedland	NWA	-20.2624	118.6325	16/06/2010	M
14800	Port Hedland	NWA	-20.2624	118.6325	16/06/2010	M
14801	Port Hedland	NWA	-20.2624	118.6325	16/06/2010	F
14802	Port Hedland	NWA	-20.2889	118.6177	17/06/2010	M
14803	Port Hedland	NWA	-20.2889	118.6177	17/06/2010	M
14804	Port Hedland	NWA	-20.2889	118.6177	17/06/2010	M
14806	Port Hedland	NWA	-20.2791	118.6725	17/06/2010	F
14807	Port Hedland	NWA	-20.2791	118.6725	17/06/2010	F
14808	Port Hedland	NWA	-20.2605	118.6339	18/06/2010	M
14809	Port Hedland	NWA	-20.2605	118.6339	18/06/2010	F
14810	Port Hedland	NWA	-20.2605	118.6339	18/06/2010	M
14811	Port Hedland	NWA	-20.2671	118.6281	18/06/2010	M
14812	Port Hedland	NWA	-20.2671	118.6281	18/06/2010	M
14813	Dampier	NWA	-20.622	117.7569	20/06/2010	F
14814	Port Hedland	NWA	-20.2253	118.5711	23/06/2010	M

***Supporting Table S4.2*. (continued)**

14815	Port Hedland	NWA	-20.298	118.3659	24/06/2010	F
14816	Port Hedland	NWA	-20.298	118.3659	24/06/2010	M
14817	Port Hedland	NWA	-20.298	118.3659	24/06/2010	M
14818	Port Hedland	NWA	-20.298	118.3659	24/06/2010	F
14819	Port Hedland	NWA	-20.2644	118.3887	24/06/2010	F
14820	Port Hedland	NWA	-20.2644	118.3887	24/06/2010	F
14821	Port Hedland	NWA	-20.2644	118.3887	24/06/2010	F
14822	Port Hedland	NWA	-20.2644	118.3887	24/06/2010	F
14823	Port Hedland	NWA	-20.2654	118.3127	27/06/2010	M
14824	Port Hedland	NWA	-20.2654	118.3127	27/06/2010	M
14825	Port Hedland	NWA	-20.2594	118.4196	27/06/2010	F
14826	Broome	NWA	-17.9879	122.1842	3/07/2010	M
14827	Broome	NWA	-17.9933	122.1874	3/07/2010	F
14828	Broome	NWA	-17.823	122.1912	6/07/2010	M
14829	Broome	NWA	-17.823	122.1912	6/07/2010	F
14830	Broome	NWA	-17.8232	122.1912	7/07/2010	M
14831	Broome	NWA	-17.8232	122.1912	7/07/2010	M
14832	Broome	NWA	-17.8232	122.1912	7/07/2010	F
14833	Broome	NWA	-17.8232	122.1912	7/07/2010	F
14834	Broome	NWA	-17.8232	122.1912	7/07/2010	F
14835	Broome	NWA	-17.7254	122.1978	11/07/2010	F
14836	Broome	NWA	-18.3032	122.1229	25/07/2010	F
14837	Broome	NWA	-18.2821	122.1346	25/07/2010	F
14838	Broome	NWA	-18.2821	122.1345	25/07/2010	F
14839	Broome	NWA	-18.2768	122.1301	25/07/2010	F
14840	Broome	NWA	-18.2795	122.1204	25/07/2010	M
14841	Broome	NWA	-18.2795	122.1204	25/07/2010	M
14842	Broome	NWA	-17.9911	122.1885	26/07/2010	M
14843	Broome	NWA	-17.9911	122.1885	26/07/2010	M
14844	Broome	NWA	-17.7636	122.1785	27/07/2010	F
14845	Broome	NWA	-17.7505	122.189	27/07/2010	M
14847	Broome	NWA	-17.988	122.2942	28/07/2010	F
14848	Ningaloo offshore samples	NWA	-21.8526	113.9233	19/07/2009	F
14849	Ningaloo offshore samples	NWA	-21.8526	113.9233	19/07/2009	M
14850	Ningaloo offshore samples	NWA	-21.8526	113.9233	19/07/2009	M
23258	North Kimberly coast	NWA	-33.4538	151.4507	?	F
23259	North Kimberly coast	NWA	-36.9894	149.9634	?	F
23260	North Kimberly coast	NWA	-16.1092	123.6841	?	F
23261	North Kimberly coast	NWA	-14.3815	125.4858	?	F
23262	North Kimberly coast	NWA	-14.307	125.7385	?	F
23263	North Kimberly coast	NWA	-14.424	125.7935	?	M
23264	North Kimberly coast	NWA	-14.3602	125.9033	?	M
23265	North Kimberly coast	NWA	-14.275	125.9473	?	M
23266	North Kimberly coast	NWA	-14.1898	126.0461	?	M
23267	North Kimberly coast	NWA	-14.1366	126.134	?	F

***Supporting Table S4.2*. (continued)**

23268	North Kimberly coast	NWA	?	?	?	M
23270	North Kimberly coast	NWA	-14.0407	126.2988	?	M
14000	Cobourg	NT	-11.1561	132.0878	25/06/2003	M
14001	Cobourg	NT	-11.1561	132.0878	25/06/2003	M
14002	Cobourg	NT	-11.1561	132.0878	25/06/2003	M
14003	Darwin	NT	-12.3485	130.6048	28/06/2003	M
14005	Darwin	NT	-12.3485	130.6048	28/06/2003	M
14006	Darwin	NT	-12.5425	130.4908	28/06/2003	M
23187	Darwin	NT	-12.45	130.8333	01/061995	M
23188	Darwin	NT	-12.45	130.8333	01/061995	F
23189	Darwin	NT	-12.45	130.8333	01/061995	M
23190	Darwin	NT	-12.45	130.8333	01/061995	F
23191	Darwin	NT	-12.45	130.8333	01/061995	M
23194	Darwin	NT	-12.45	130.8333	01/061995	M
23195	Darwin	NT	-12.45	130.8333	01/061995	F
23478	Cobourg	NT	-11.2672	132.1111	25/03/2009	M
23479	Cobourg	NT	-11.2351	132.1871	5/09/2009	F
23480	Cobourg	NT	-11.2648	132.113	10/09/2009	M
23481	Cobourg	NT	-11.2661	132.1106	10/09/2009	F
23482	Darwin	NT	-12.3244	130.9398	26/08/2008	M
23483	Darwin	NT	-12.4237	130.8145	15/09/2008	M
23484	Darwin	NT	-12.4206	130.8291	28/10/2008	M
23485	Darwin	NT	-12.4692	130.8615	17/04/2009	M
23486	Darwin	NT	-12.4692	130.8615	18/11/2009	?
23487	Groote	NT	-13.75	136.84	22/01/2009	M
23488	Cobourg	NT	-11.249	132.1457	15/11/2010	F
23489	Cobourg	NT	-11.249	132.1381	15/11/2010	F

Supporting Table S4.3. Museum and type specimens of *Tursiops* analyzed in the study. Specimens are sorted by institution (name as allocated by the museum). Data include ID, sex, locality, state/territory and stranding date. Missing data = ?, specimens used for comparison between genetics and morphological results are bold and marked with *, and *T. australis* specimens (Charlton-Robb *et al*. 2011) are bold and marked with #. Bone or teeth samples were collected for most museum specimens, except from South Australian Museum where the registration number is underlined for specimens for which we had soft tissue samples for.

Museum	ID	Locality	State/ territory	Stranding date	Sex
Western	M6845	Carnarvon area	WA	8/03/1966	?
Australian	M28138	NT	NT	30/09/1985	M
Museum,	***M28135**	NT	NT	3/10/1985	M
Perth	M55192	Meerup Beach	WA	6/08/1945	?
	***M42286**	Dubaut Point Monkey Mia	WA	12/04/1993	?
	M1228	Cape Leeuwin	WA	11/03/1930	?
	M2947	Kukerin?	WA?	6/08/1953	?
	M1192	Swan River Estuary	WA	26/09/1929	?
	M60866	?	?	?	?
	M4794	Esperance	WA	22/02/1958	?
	***M5723**	Rottnest Island	WA	10/04/1963	?
	M6384	Shell Bch Peron Peninsula	WA	29/10/1964	F
	M6395	Swanbourne	WA	26/11/1964	M
	M7028	Yallingup	WA	?	?
	M7044	Long Is Hontman Abrolhos	WA	18/05/1905	?
	M7499	Point Peron	WA	29/11/1966	?
	M7584	John Point (Garden Island?)	WA	25/01/1967	?
	M7871	Manypeaks (Albany)	WA	17/12/1967	?
	M9098	Rockingham	WA	27/11/1970	?
	M7881	?	?	?	?
	M7870	Boranup	WA	1/06/1967	?
	M11387	Barrow Island	WA	25/05/1905	?
	M15245	?	?	17/05/1968	?
	M15246	Parry inlet	WA	1/09/1971	?
	M15249	Jurien Bay	WA	21/01/1970	?
	M15255	Herald Bight	WA	30/01/1977	?
	M16293	no data - John Dell's dam burial ground	WA?	?	?
	M16298	Hopetown	WA	20/01/1983	?
	M25813	no data - skull found in collection	?	?	?
	M26631	Unknown (Hembree)	NT?	8/06/1905	?
	M26633	Unknown	NT?	8/06/1905	?
	***M28131**	Unknown (Hembree)	NT	30/09/1984	M
	M28125	Unknown	NT	1/10/1985	M
	***M28126**	Elizabeth River	NT	6/06/1905	M
	M28127	Unknown (Hembree)	NT	2/10/1985	F
	***M28136**	Unknown (Hembree)	NT	1/10/1985	M
	M28140	Unknown (Hembree)	NT	11/10/1985	M
	***M42285**	Nanya Shark Bay	WA	14/10/1992	F
	M29122	Garden Island	WA	19/01/1989	?
	***M36671**	?	WA	1/09/1991	?

***Supporting Table S4.3*. (continued)**

	M54135	Matilda Bay Swan River	WA	16/01/1979	?
	***M54141**	Floreat Beach	WA	15/09/1984	F
	***M52395**	Monkey Mia	WA	?	?
	M28151	Unknown (Hembree)	NT	19/10/1985	M
	M11940	Baba Head Shark Bay	WA	14/08/1970	?
	M11941	Nanga Bay near Shark Bay	WA	?	?
Museum and	U5151	Arafura Sea	NT	3/10/1983	F
Art Gallery of	***U0523**	Arafura Sea	NT	21/01/1984	?
the Northern	U0692	Arafura Sea	NT	10/10/1985	?
Territory,	U0515	Arafura Sea	NT	23/10/1983	?
Darwin	U0512	Arafura Sea	NT	13/10/1984	?
	U0524	Timor Sea	WA	9/08/1983	?
	U0511	Arafura Sea	NT	21/01/1984	?
	U0663	Timor Sea	NT	25/09/1984	?
	***U0665**	Timor Sea	NT	29/09/1984	?
	U0526	Arafura Sea	NT	12/08/1985	?
	***U0661**	Arafura Sea	NT	1/12/1983	?
	U0758	Arafura Sea	NT	9/11/1983	F
	U0659	Arafura Sea	NT	8/11/1983	?
	U0658	Arafura Sea	NT	8/11/1983	?
	U0519	Arafura Sea	NT	9/12/1983	?
	U0666	Arafura Sea	NT	26/09/1984	?
	***U5095**	?	?	?	?
	***U0662**	Arafura Sea	NT	3/12/1983	?
	U0245	Timor Sea	WA	11/09/1984	?
	***U0691**	Arafura Sea	NT	1/12/1983	?
	***U0693**	Arafura Sea	NT	1/12/1983	?
	***U0694**	Arafura Sea	NT	9/11/1983	?
	***U0695**	Arafura Sea	NT	13/10/1983	F
	***U0533**	Arafura Sea	NT	13/10/1984	?
	***U0534**	Arafura Sea	NT	9/11/1983	?
	***U0537**	Arafura Sea	NT	1/12/1983	?
	***U0535**	Arafura Sea	NT	1/12/1983	?
	***U0517**	Arafura Sea	NT	26/01/1984	?
	***U0241**	Beach Ne. Murgenella	NT	5/06/1985	?
	***U3955**	Maria Island	NT	27/07/1972	?
	***U3956**	Marchinbar Island-Cape Wessel	NT	6/10/1972	?
	***U0513**	Arafura Sea	NT	13/08/1985	M
	***U0527**	Arafura Sea	NT	3/12/1983	?
	***U0521**	Arafura Sea	NT	14/08/1985	F
	***U5635**	Arafura Sea	NT	1/12/1983	?
	U0518	Arafura Sea	NT	?	?
	U0668	Arafura Sea	NT	?	?
Museum of	JM4713	Horseshoe Bay Magnetic Is	QLD	17/08/1971	F
Tropical	JM4724	Horseshoe Bay Magnetic Is	QLD	7/10/1972	M

***Supporting Table S4.3*. (continued)**

Queensland,	JM4715	Horseshoe Bay Magnetic Is	QLD	10/09/1971	F
Townsville	***MM1018**	?	QLD?	?	?
	***Percy Island**	Percy Island	QLD	1/08/1969	?
	***MM91A**	Great Palm Island	QLD	12/07/1976	?
	Tursiops	Great Palm Island	QLD	1/06/1974	?
Queensland	***JM11375**	Bargara Beach	QLD	4/03/1996	M
Museum,	JM11980	Kirra Beach Gold Coast	QLD	5/08/1997	?
Brisbane	***JM10114**	Point Lookout Nth Stradbroke Is	QLD	14/08/1993	?
	JM6436	Southport	QLD	30/11/1974	?
	***JM7015**	Bundaberg	QLD	24/05/1944	?
	JM1230	Moreton Bay	QLD	1/12/1975	F
	J5653	Bribie Is	QLD	27/06/1934	?
	***JM6568**	Yellow Patch Moreton Is	QLD	8/05/1988	F
	***JM6428**	White Rock Ocean Beach Moreton Is	QLD	22/02/1987	M
	JM5574	Moreton Is	QLD	19/12/1986	?
	***JM5411**	Elcho Is via Darwin	QLD?	?	?
	***JM5241**	?	QLD	5/06/1905	?
	***J6421**	Nth Stradbroke Is Point Lookout area	QLD	25/07/1938	?
	JM10043	Nth Stradbroke Is Chiggil Chiggil S of Amity	QLD	14/06/1905	?
	JM8859	Maroochydore	QLD	5/06/1986	F
	JM4155	Townsville	QLD	24/10/1924	?
	***J3849**	Burleigh Heads	QLD	17/07/1923	?
	JM6678	Moollolaba	QLD	3/06/1940	?
	J2412-3	Bustard head	QLD	9/07/1950	?
	J2647	Moreton Bay	QLD	21/12/1915	?
Australian	M38699	?	?	23/03/2006	?
Museum,	M36407	Port Stephens	NSW	4/07/2002	M
Sydney	***S478**	?	?	1/01/1900	?
	M23	?	?	1/01/1900	?
	M25870	S of Black Rocks Bundjalung National Park	NSW	29/07/1991	?
	M22838	Hat Head near Kempsey 32 km S of Coffs Harbour	NSW	25/10/1990	F
	M33555	?	?	13/11/1991	?
	***M10853**	Nowra	NSW	30/01/1971	?
	***B10527**	?	?	?	?
	***M12402**	Newport Beach	NSW	1/09/1971	?
	PA278	?	?	?	?
	***PA280**	?	?	?	?
	S1555	La Perouse Botany Bay Sydney	NSW	24/03/1920	?
	***S477**	?	?	1/01/1900	?
	***P279**	Port Stephens	NSW	5/10/1900	?
	***S2097**	Pelsart Island Houtman Abrolhos	WA	7/03/1946	?
	***P307**	?	?	2/11/1900	?
	***S1778**	Cape Cleveland near Townville	QLD	12/11/1904	?

***Supporting Table S4.3*. (continued)**

	305	Bega	NSW	31/10/1900	?
	308	?	?	3/11/1900	?
	306	?	?	1/11/1900	?
	Unregistered	?	?	?	?
	***M10852**	2 miles S of Crowdy Head via Taree	NSW	2/01/1971	?
	M25871	1.5 km N of Byron Bay	NSW	7/08/1991	F
	B10526	Port Jackson	NSW	?	?
	***M32212**	Black Head Beach N of Forster	NSW	1/03/1995	?
	M22971	Laurieton	NSW	19/03/1986	F
	***M33286**	?	?	17/02/1991	?
	P277	?	?	3/10/1900	?
	M28255	Coffs Harbour	NSW	11/08/1992	?
Museum	***C29581**	East Beach Port Fairy	VIC	22/02/1986	M
Victoria,	***C24989**	Point Danger	VIC	14/07/1979	?
Melbourne	***C11271**	Thalia Point Lake Victoria	VIC	?	?
	***#C29579**	Western Beach Geelong	VIC	14/10/1985	F
	***C29462**	Red Bluff Beach Port Phillip Bay	VIC	3/01/1983	?
	C24966	Lakes Entrance to east of entrance	VIC	1/08/1979	?
	***#C24944**	Elwood	VIC	23/06/1967	F
	***C28972**	San Remo	VIC	25/11/1991	F
	***#C29667**	Ocean Grove	VIC	8/01/1987	F
	***#C25071**	Stingaree Bay	VIC	20/12/1979	?
	***#C29506**	Tideway Beach near Sorrento	VIC	16/04/1994	F
	***C29578**	Altona	VIC	12/09/1985	F
	***#Unknown**	Point Hibbs or Jones Bay	VIC	?	?
	***#C10357**	?	?	?	?
	***#C29577**	Safety Beach	VIC	23/07/1985	F
	***#C29586**	Rippleside Beach	VIC	27/07/1991	M
	***#C35965**	Lake Wellington north shore 1 Km N. of McLennan Strait	VIC	14/12/2006	?
	***#C35966**	Lake Wellington north shore 1.5 Km N. of McLennan Strait	VIC	14/12/2006	?
	***C35968**	Lake Wellington Poddy Bay	VIC	4/09/2006	?
	***C35969**	Sunderland Bay Surfies Point	VIC	8/03/2006	?
	***C35984**	Port Fairy South-East Beach	VIC	26/10/2006	?
	***#C35985**	Gippsland Lakes Lak Blonde Baye Wellington	VIC	29/11/2006	?
	***#C35986**	Bairnsdale Mitchell R	VIC	26/03/2006	?
	***#C35987**	McMillan Strait near Hollands Landing Bairnsdale	VIC	21/07/2006	?
	C36749	Western Port Coronet Bay	VIC	29/06/1905	?
	***#C36750**	Paynesville	VIC	29/06/1905	?
Tasmanian	***A199**	?	?	?	?
Museum and	***A1289**	Ralph's Bay	TAS	26/01/1978	?
Art Gallery,	***A2443**	?	?	?	?
Hobart	***A1759**	Marion Bay	TAS	21/02/2003	?
	***A2425**	?	?	?	?
	***Unregistered1**	?	?	?	?

***Supporting Table S4.3*. (continued)**

	***A2430**	?	?	?	?
	***A198**	Lisdillon	TAS	25/09/1920	?
Queen Art	***35**	Bass Strait	TAS	00/00/1965	?
Museum and	***19**	Bluffy Beach Whitemark Flinders Island	TAS	14/09/1974	M
Gallery,	***8**	Hoblers Bridge North Esk River	TAS	7/01/1946	M
Launceston	Not registered	Eaglehawk Neck Tas peninsula	TAS	10/02/1981	?
Victoria	***1362**	Bass Strait	TAS	22/02/1902	M
	***1361**	NW Tas	TAS	00/00/1903	M
	***1365** (syntype of Tursiops maugeanus holotype of Tursiops australis)	Hoblers Bridge North Esk River	TAS	11/11/1914	F
	***1360** (syntype of Tursiops maugeanus)	Cataract Gorge Launceston	TAS	1/10/1902	M
South	***M1075**	Nalpa	SA	?	?
Australian	***M1078**	Meningie	SA	?	?
Museum,	M3268	Point Pearce	SA	1/07/1932	?
Adelaide	M5902	Woods Well	SA	?	?
	***M6038**	Murray Mouth	SA	1/05/1955	?
	***M10101**	D'Estrees Bay Kangaroo Island	SA	20/03/1974	F
	***M11097**	Memory Cove	SA	4/05/1977	F
	M11098	Memory Cove	SA	4/05/1977	F
	M11099	Memory Cove	SA	4/05/1977	F
	M11100	Memory Cove	SA	4/05/1977	F
	M11101	Memory Cove	SA	4/05/1977	M
	***M11102**	Memory Cove	SA	4/05/1977	M
	***M11103**	Memory Cove	SA	4/05/1977	F
	M11104	Memory Cove	SA	4/05/1977	M
	***M11105**	Memory Cove	SA	4/05/1977	F
	M11106	Memory Cove	SA	4/05/1977	M
	M11107	Memory Cove	SA	4/05/1977	M
	***M11108**	Memory Cove	SA	4/05/1977	M
	***M14449**	Snug Cove Mouth of De Mole River Kangaroo Island	SA	1/04/1987	?
	***M14450**	Snug Cove Mouth of De Mole River Kangaroo Island	SA	1/04/1987	?
	M15025	Kingston Lacepede Bay	SA	13/01/1989	F
	***M15820**	Ceduna Great Australian Bight	SA	1960	?
	M21326	Flinders Island Bass Strait	TAS	14/04/1905	?
	M24456	Fitzgerald Bay Spencer Gulf Point Lowly (lighthouse)	SA	2/11/2006	M
	***M20878**	Kingscote Western Cove Nepean Bay Kangaroo Island	SA	22/03/1999	F
	***M16264**	Carpenter Rocks Southern Ocean	SA	13/12/1989	M
	***M23334**	Emu Bay Investigator Straight	SA	24/09/2004	M
	***M23361**	Point Tinline D'Estrees Bay Kangaroo Island	SA	9/04/2004	M
	***M19974**	Pirates Bay Tasman Peninsula South Pacific Ocean	TAS	16/01/1997	F

***Supporting Table S4.3*. (continued)**

***M20747**	Strawbridge Point Kangaroo Island Investigator Strait	SA	16/04/1999	M
***M20744**	Brown Beach Eastern Cove Kangaroo Island	SA	23/04/1999	F
***M21255**	Murray Mouth Encounter Bay	SA	23/06/1999	F
***M21022**	Cape Martin Southern Ocean	SA	26/09/1999	M
***M20741**	Goolwa Beach Encounter Bay	SA	25/11/1999	M
***M18051**	Pelican Point Southern Ocean	SA	21/07/1994	F
***M24339**	Almonta Beach Coffin Bay	SA	3/02/2009	F
***M24722**	American River (PO)	SA	3/10/2007	M
***M24723**	American River (PO)	SA	5/10/2007	F
***M20736**	Port Adelaide Gulf St Vincent	SA	30/07/1998	M
***M15598**	South Beach Port Hughes Spencer Gulf	SA	8/06/1989	M
***M16428**	Port Broughton Spencer Gulf	SA	?	M
***M16427**	Granite Island Encounter Bay Southern Ocean	SA	21/01/1991	F
***M16426**	Stenhouse Bay Investigator Strait	SA	21/02/1991	F
***M18052**	Port Lincoln Boston Bay Spencer Gulf	SA	12/02/1994	M
***M18053**	Port Lincoln Boston Bay Spencer Gulf	SA	24/03/1994	M
***M19979**	Point Longnose Coffin Bay Eyre Peninsula	SA	29/03/1997	M
***M16392**	Collins Beach Hardwicke Bay Spencer Gulf	SA	22/06/1990	M
***M16972**	Marion Bay Investigator Strait Southern Ocean	SA	9/11/1991	F
***M18055**	Port Lincoln Boston Bay Spencer Gulf	SA	4/01/1900	M
***M18902**	Port Lincoln Boston Bay Spencer Gulf	SA	17/06/1905	M
***M18095**	Cape Donington Spencer Gulf Lincoln National Park	SA	7/11/1995	F
***M18088**	Port Lincoln Spencer Gulf Boston Bay	SA	1/03/1995	F
***M18086**	Port Lincoln Spencer Gulf Boston Bay	SA	9/03/1995	F
***M18093**	Port Lincoln	SA	4/04/1995	F
***M19953**	Semaphore Gulf St Vincent	SA	9/03/1996	F
***M19954**	Venus Bay Eyre Peninsula	SA	23/04/1996	F
***M19965**	Port Lincoln Boston Bay Spencer Gulf	SA	13/03/1996	M
***M19952**	Mount Dutton Bay Coffin Bay Great Australian Bight	SA	28/12/1996	M
***M19978**	Port Adelaide Gulf St Vincent	SA	27/05/1997	M
***M19968**	Louth Bay Spencer Gulf	SA	8/04/1997	M
***M19973**	Port Noarlunga Gulf St Vincent	SA	4/07/1997	F
***M20733**	Wool Bay Yorke Peninsula Gulf St Vincent	SA	1/12/1997	M
***M20737**	Torrens Island Barker Inlet Gulf St Vincent	SA	26/07/1998	M
***M21235**	Rapid Bay Gulf St Vincent	SA	30/08/1998	F
***M20734**	Christies Beach Gulf St Vincent	SA	16/09/1998	F
***M20874**	Coffin Bay Great Australian Bight	SA	23/08/1998	F
***M18048**	Port Lincoln Boston Bay Spencer Gulf	SA	17/10/1994	M
***M24340**	Sellicks Beach	SA	20/11/2005	F
***M24294**	Streaky Bay (PO)	SA	5/01/2006	F
***M24725**	Emu Bay (township)	SA	18/02/2008	F
***M19969**	Port Germein Bay Spencer Gulf	SA	8/05/1997	F

***Supporting Table S4.3*. (continued)**

	***M24896**	Thompson Beach	SA	6/01/2009	F
	***M24292**	Nene Valley	SA	10/07/2006	M
	***M25496**	Arno Bay	SA	26/02/2008	M
	***M21314**	St Kilda Barker Inlet Gulf St Vincent	SA	30/07/1998	F
	***M22532**	Fowlers Bay Great Australian Bight	SA	4/04/2002	M
	***M22549**	Port Adelaide Outer Harbour Gulf St Vincent	SA	14/03/2003	M
	***M23323**	Adelaide Gulf St Vincent	SA	13/12/2003	F
	***M23325**	Smoky Bay Great Australian Bight	SA	31/03/2004	M
Natural History Museum, London	***353.a.** (holotype of Delphinus truncatus)	Duncannon Pool near Stoke Gabriel River Dart Devonshire	England	03/07/1804	
	***1862.6.6.13** (syntypes of Delphinus catalania)	Cape Melville Island	QLD	05/09/1860	F
	1862.6.6.14 (syntypes of Delphinus catalania)	Cape Melville Island	QLD	09/10/1860	
Museum für Naturkunde, Berlin	***ZMB66400** (holotype of Delphinus aduncus), GeneBank no DQ517442	Insel Belhosse am Strand angespült	Red Sea	13/04/1825	

Supporting Information 4.4. Extraction and molecular sexing methods, PCR conditions for *Tursiops* spp. soft tissue and museum samples in the present study.

Molecular Sexing
The loci were simultaneously amplified in a 10 µl reaction volume containing 1 µl (20ng/µl) genomic DNA, 0.2 mM dNTPs, 0.12 mM MgCl2, 1 µl PCR buffer (Qiagen), 0.2 u/µl Jumpstart Taq polymerase (Sigma), 7 µl ddH2O and 0.15 µM each (ZFX and SRY) of forward and reverse primers. The PCR profile consisted of initial denaturation at 95°C/2 min, followed by 40 cycles with 94°C/30 s denaturation, 60°C/45 s annealing and 72°C/45 s extension and a final extension at 72°C/2 min.

Mitochondrial DNA genotyping
Polymerase chain reactions for all soft tissue samples (n = 648) was carried out using JumpStarTaq master mix (Qiagen), performed in a 10 µl reaction volume containing 20 ng genomic DNA, 0.1 U JumpStarTaq DNA Polymerase, 1 µl PCR buffer (both QIAGEN), 0.3 mM final concentration MgCl2, 0.1 mM deoxynucleotide triphosphates, 0.1 µM each of forward and reverse primers. The PCR conditions consisted of an initial denaturation at 94°C/3 min, followed by a 10-cycle 'touchdown' (94°C for 30 s, 63-53°C for 30 s and 72°C for 1 min) and 35 cycles with 93°C/30 s denaturation, 52°C/30 s annealing and 72°C/1 min extension and a final extension at 72°C/10 min.

PCR amplification for all teeth/bone samples (n = 210) was done using AmpliTaq Gold PCR Master Mix (Applied biosystems), performed in a 20 µl reaction volume containing 2 ng genomic DNA, 0.1 U AmpliTaq Gold PCR master mix, 0.4 µg/µl Bolvine Serum Albumin (BSA), 0.4 µM each of forward and reverse primers. PCR conditions consisted of an initial denaturation at 95°/15 min, followed by a 10-cycle 'touchdown' (94°C for 30 s, 63-53°C for 30 s and 72°C for 1 min) and 45 cycles with 94°/30 s denaturation, 52°/30 s annealing and 72°/1 min extension and a final extension at 72°/10 min.

Y-chromosome genotyping
The PCR reactions for the for the for the four Y-chromosome loci were conducted in a 20 µl reaction volume containing 20 ng genomic DNA, 0.5U HotStarTaq DNA Polymerase (QIAGEN), 1µl PCR Buffer (QIAGEN), 0.3mM final concentration MgCl2, 0.1mM deoxynucleotide triphosphates, and 0.1 µM of each forward and reverse primers. The PCR conditions for primers DBY7 and SMCY7 consisted of an initial denaturation at 95°C/15 min, followed by a 20-cycle "touchdown" (95°C for 30 s, 65°C to 55°C for 45 s decreasing by 0.5°C/cycle, and 72°C for 45 s) and 20 cycles with 95°C/30 s denaturation, 55°C/45 s annealing and 72°C/45 s extension, followed by a final extension at 72°C/10min. Cycle conditions for UTY11 and DBY9 were the same except for the touchdown temperature of 55°C to 45°C decreasing by 0.5°C/cycle.

Supporting Table S4.5. Pairwise fixation index F_{ST} and R_{ST} values for 19 microsatellite loci for *T. aduncus* as identified by STRUCTURE. Significance level of $P > 0.001$ is indicated by *, numbers in bold show non-significant values. Twenty three geographical sampling locations were identified; Town = Townsville (QLD), Kepp = Keppel Bay (QLD), Bunk = Bunker group reef (QLD), MB = Morton Bay (QLD), NSW = northern New South Wales (NSW), G SV = Gulf St Vincent (SA), SG = Spencer Gulf (SA), PL = Port Lincoln (SA), Coff = Coffin Bay (SA), W SA = western South Australia (SA), Aug = Augusta (southern WA), Bun = Bunbury (southern WA), Perth (southern WA), E SB = eastern Shark Bay (central WA), W SB = western Shark Bay (central WA), CB = Coral Bay (northern WA), Ex = Exmouth (northern WA), Ons = Onslow (northern WA), Dam = Dampier (northern WA), PH = Port Hedland (northern WA), Bro = Broome (northern WA), Cob = Cobourg (NT), and Darw = Darwin (NT).

F_{ST}\R_{ST}	Town	Kepp	Bunk	MB	NSW	G SV	SG	PL	Coff	W SA	Aug	Bun	Perth	E SB	W SB	CB	Ex	Ons	Dam	PH	Bro	Cob	Darw
Town (QLD)		**0.014**	**0.042**	**-0.022**	0.046*	0.154*	0.173*	0.326*	0.229*	0.234*	0.163*	0.147*	0.109*	0.130*	0.119*	0.067*	0.146*	0.130*	0.043*	0.098*	0.060*	**-0.054**	**-0.007**
Kepp (QLD)	**0.034**		0.054*	**0.023**	0.049*	0.111*	0.150*	0.297*	0.216*	0.241*	0.222*	0.143*	0.136*	0.156*	0.133*	0.086*	0.181*	0.165*	0.087*	0.067*	0.050*	0.073*	0.091*
Bunk (QLD)	**0.018**	**0.007**		0.081*	0.041*	0.144*	0.155*	0.197*	0.173*	0.239*	0.275*	0.197*	0.170*	0.078*	0.091*	0.045*	0.120*	0.079*	0.088*	0.092*	0.108*	0.019*	0.053*
MB (QLD)	0.051*	0.041*	0.037*		0.093*	0.136*	0.166*	0.318*	0.215*	0.203*	0.177*	0.132*	0.117*	0.149*	0.130*	0.101*	0.175*	0.183*	0.078*	0.097*	0.072*	0.056*	0.080*
N NSW (NSW)	0.118*	0.053*	0.083*	0.106*		0.078*	0.086*	0.229*	0.157*	0.238*	0.364*	0.269*	0.213*	0.126*	0.107*	0.048*	0.121*	0.067*	0.065*	0.124*	0.098*	0.032*	**-0.020**
G SV (SA)	0.200*	0.157*	0.187*	0.252*	0.190*		**-0.035**	0.096*	0.055*	0.078*	0.203*	0.162*	0.112*	0.125*	0.099*	0.059*	0.128*	0.123*	0.086*	0.123*	0.114*	0.107*	0.072*
SG (SA)	0.244*	0.195*	0.232*	0.285*	0.228*	0.071*		**0.056**	0.018*	0.054*	0.226*	0.185*	0.125*	0.107*	0.087*	0.052*	0.093*	0.075*	0.076*	0.130*	0.129*	0.113*	0.081*
PL (SA)	0.244*	0.198*	0.212*	0.280*	0.228*	0.041*	0.034*		0.089*	0.179*	0.372*	0.342*	0.255*	0.134*	0.149*	0.131*	0.148*	0.123*	0.187*	0.247*	0.276*	0.205*	0.168*
Coff (SA)	0.233*	0.186*	0.221*	0.273*	0.220*	0.095*	0.132*	0.121*		0.047*	0.272*	0.234*	0.174*	0.094*	0.081*	0.041*	0.044*	0.027*	0.065*	0.133*	0.131*	0.147*	0.086*
W SA (SA)	0.196*	0.156*	0.192*	0.242*	0.222*	0.076*	0.119*	0.090*	0.040*		0.212*	0.248*	0.147*	0.130*	0.106*	0.082*	0.057*	0.064*	0.057*	0.188*	0.128*	0.169*	0.116*
Aug (S WA)	0.194*	0.192*	0.211*	0.273*	0.269*	0.231*	0.228*	0.211*	0.192*	0.161*		0.134*	0.029*	0.158*	0.142*	0.165*	0.198*	0.227*	0.096*	0.192*	0.159*	0.137*	0.139*
Bun (S WA)	0.236*	0.212*	0.236*	0.276*	0.274*	0.254*	0.263*	0.245*	0.183*	0.146*	0.064*		0.017*	0.118*	0.076*	0.107*	0.168*	0.216*	0.082*	0.060*	0.081*	0.105*	0.146*
Perth (S WA)	0.229*	0.190*	0.217*	0.271*	0.233*	0.225*	0.226*	0.206*	0.176*	0.137*	0.034*	0.028*		0.070*	0.060*	0.081*	0.133*	0.141*	0.056*	0.096*	0.098*	0.064*	0.105*
E SB (C WA)	0.169*	0.154*	0.149*	0.218*	0.200*	0.189*	0.216*	0.192*	0.151*	0.123*	0.092*	0.109*	0.084*		**-0.003**	0.027*	0.058*	0.004*	0.052*	0.083*	0.119*	0.053*	0.070*
W SB (C WA)	0.167*	0.157*	0.159*	0.218*	0.199*	0.183*	0.199*	0.169*	0.163*	0.117*	0.096*	0.101*	0.084*	0.026*		0.015*	0.048*	0.008*	0.033*	0.051*	0.081*	0.053*	0.070*
CB (N WA)	0.112*	0.123*	0.118*	0.181*	0.194*	0.182*	0.214*	0.192*	0.149*	0.134*	0.111*	0.112*	0.117*	0.055*	0.057*		**-0.004**	**-0.022**	0.004*	0.025*	0.029*	0.013*	**-0.013**
Ex (N WA)	0.143*	0.152*	0.143*	0.210*	0.194*	0.187*	0.218*	0.183*	0.162*	0.139*	0.109*	0.124*	0.119*	0.067*	0.043*	**0.005**		**-0.036**	0.027*	0.095*	0.086*	0.077*	0.061*
Ons (N WA)	0.111*	0.120*	0.114*	0.174*	0.158*	0.154*	0.203*	0.160*	0.121*	0.088*	0.117*	0.129*	0.122*	0.049*	0.044*	**0.002**	**0.002**		**-0.010**	0.080*	**0.072**	0.044*	0.027*
Dam (N WA)	0.120*	0.124*	0.124*	0.178*	0.158*	0.166*	0.200*	0.162*	0.142*	0.102*	0.115*	0.110*	0.100*	0.076*	0.053*	0.023*	0.016*	**-0.006**		0.046*	0.016*	0.018*	0.035*
PH (N WA)	0.144*	0.137*	0.144*	0.194*	0.176*	0.176*	0.207*	0.180*	0.140*	0.112*	0.109*	0.096*	0.084*	0.051*	0.045*	0.028*	0.026*	**0.020**	0.012*		0.015*	0.078*	0.085*
Bro (N WA)	0.092*	0.102*	0.106*	0.160*	0.146*	0.152*	0.175*	0.144*	0.136*	0.077*	0.094*	0.112*	0.104*	0.080*	0.064*	0.019*	0.031*	**0.005**	**0.008**	0.028*		0.064*	0.069*
Cob (NT)	**0.041**	0.105*	0.107*	0.172*	0.162*	0.144*	0.165*	0.149*	0.161*	0.119*	0.130*	0.167*	0.159*	0.120*	0.110*	0.090*	0.095*	0.087*	0.080*	0.093*	0.075*		**-0.043**
Darw (NT)	0.072*	0.107*	0.108*	0.164*	0.157*	0.170*	0.157*	0.165*	0.165*	0.143*	0.115*	0.155*	0.145*	0.101*	0.098*	0.056*	0.079*	0.070*	0.078*	0.083*	0.076*	**0.020**	

Supporting Table S4.6. Pairwise fixation index F_{ST}, and R_{ST} values for 19 microsatellite loci for *T. truncatus* as identified by STRUCTURE. Significance level of $P > 0.001$ is indicated by *, numbers in bold show non-significant values. Twelve geographical sampling locations were identified; Bunk = Bunker group reef (QLD), MB = Moreton Bay (QLD), N NSW = northern NSW (NSW), E VIC = eastern VIC, PPB = Port Phillip Bay (VIC), E TAS = eastern TAS, W TAS = western TAS, N TAS = northern TAS, King = King Island (TAS), KI = Kangaroo Island (SA), W Pil = western Pilbara (WA), and E Pil = eastern Pilbara (WA).

***F*st*R*st**	**Bunk**	**MB**	**N NSW**	**E VIC**	**PPB**	**E TAS**	**W TAS**	**N TAS**	**King**	**KI**	**W Pil**	**E Pil**
Bunk (QLD)		**0.038**	**0.005**	0.721*	0.673*	0.429*	0.188*	0.351*	0.377*	0.286*	0.160*	0.200*
MB (QLD)	**0.012**		**0.052**	0.701*	0.627*	0.307*	0.135*	0.282*	0.287*	0.164*	0.154*	0.165*
N NSW	**-0.004**	**-0.006**		0.700*	0.639*	0.350*	0.114*	0.304*	0.296*	0.205*	0.117*	0.141*
E VIC	0.482*	0.521*	0.496*		**0.047**	0.197*	0.485*	0.478*	0.457*	0.366*	0.524*	0.503*
PPB (VIC)	0.457*	0.488*	0.459*	**0.062**		**0.170**	0.393*	0.460*	0.398*	0.283*	0.469*	0.428*
E TAS	0.264*	0.245*	0.234*	0.170*	0.130*		0.202*	0.112*	0.147*	**0.023**	0.291*	0.257*
W TAS	0.230*	0.196*	0.191*	0.323*	0.269*	0.121*		0.121*	0.054*	0.052*	0.101*	0.074*
N TAS	0.250*	0.213*	0.213*	0.362*	0.311*	0.078*	0.085*		0.084*	**-0.001**	0.190*	0.196*
King (TAS)	0.242*	0.215*	0.202*	0.345*	0.296*	0.114*	**0.004**	0.067*		**0.046**	0.188*	0.143*
KI (SA)	0.216*	0.171*	0.174*	0.286*	0.217*	**0.026**	0.025*	**0.016**	0.033*		0.141*	0.106*
W Pil (N WA)	0.190*	0.161*	0.171*	0.341*	0.313*	0.160*	0.089*	0.112*	0.100*****	0.068*		**0.014**
E Pil (N WA)	0.200*	0.162*	0.171*	0.347*	0.304*	0.138*	0.062*	0.094*	0.059*	0.046*	**-0.000**	

*Supporting Table S4.7.*Genetic species summary for *Tursiops* spp. specimen included in the study based on autosomal (STRUCTURE), mtDNA (BI, NJ and ML), and concatenated Y-chromosome (BI, NJ and ML) markers. Included is a comparison with our previous morphological data (Jedensjö *et al.* in review), SABD haplotypes (identified by Bilgmann *et al.* 2007 and Pratt *et al.* 2018), and *T. australis* individuals (haplotypes identified by Charlton-Robb *et al.* 2011 marked with ^). Table sorted by mtDNA haplotype and sampling state/location. Data include sample/museum ID, sample state/location, species ID for mtDNA (including subgroup and haplotype), autosomal and Y-chromosome (including subgroup and haplotype) markers, morphological species ID, type specimens, and *T. australis* specimens. Discordant results found are marked in bold and *. QLD = Queensland, NSW = New South Wales, VIC = Victoria, TAS = Tasmania, SA = South Australia, SWA = southern Western Australia, CWA = central Western Australia, NWA = northern Western Australia, and NT = Northern Territory.

Sample and museum ID	State/location	mtDNA species ID, subgroup and haplotype	Autosomal species ID	Y-chromosome species ID, subgroup and haplotype	Morphology species	Type specimens, SABD, *T. australis*^
14598	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14599	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14600	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14601	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14602	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14603	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14604	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	*T. aduncus*, B (Y4)	-	
14506	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14517	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14518	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	*T. aduncus*, B (Y4)	-	
14512	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14558	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14019	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14021	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14608	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	*T. aduncus*, B (Y4)	-	
14611	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14612	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14613	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14617	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	*T. aduncus*, B (Y1)	-	
237	SWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
295	CWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
612	CWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
681	CWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
682	CWA	***T. truncatus*, A (H1)***	*T. aduncus*	-	-	
14119	QLD	***T. truncatus*, A (H1)***	-	-	-	
168	CWA	***T. truncatus*, A (H42)***	*T. aduncus*	-	-	
213	CWA	***T. truncatus*, A (H42)***	*T. aduncus*	-	-	
262	CWA	***T. truncatus*, A (H42)***	*T. aduncus*	-	-	
281	CWA	***T. truncatus*, A (H42)***	*T. aduncus*	-	-	
340	CWA	***T. truncatus*, A (H42)***	*T. aduncus*	-	-	
439	CWA	***T. truncatus*, A (H42)***	*T. aduncus*	*T. aduncus*, A (Y1)	-	
459	CWA	***T. truncatus*, A (H42)***	*T. aduncus*	-	-	
511	CWA	***T. truncatus*, A (H42)***	*T. aduncus*	-	-	
544	CWA	***T. truncatus*, A (H42)***	*T. aduncus*	-	-	
289	CWA	***T. truncatus*, A (H42)***	*T. aduncus*	-	-	

***Supporting Table S4.7*. (continued)**

290	CWA	***T. truncatus*, A (H42)***	*T. aduncus*	-	-	
291	CWA	***T. truncatus*, A (H42)***	*T. aduncus*	-	-	
23535	VIC	*T. truncatus*, B (H82)	*T. truncatus*	*T. truncatus* (Y2)	-	
23538	VIC	*T. truncatus*, B (H82)	-	-	-	
23543	VIC	*T. truncatus*, B (H82)	*T. truncatus*	*T. truncatus* (Y2)	-	
23547	VIC	*T. truncatus*, B (H82)	*T. truncatus*	-	-	
23551	VIC	*T. truncatus*, B (H82)	*T. truncatus*	*T. truncatus* (Y2)	-	
23394, C11271	VIC	*T. truncatus*, B (H82)	-	-	*T. truncatus*	
23405, Unknown	VIC	*T. truncatus*, B (H82)	-	-	*T. truncatus*	***T. australis*^**
C35966, C35966	VIC	*T. truncatus*, B (H82)	-	-	*T. truncatus*	***T. australis*^**
23544	VIC	*T. truncatus*, B (H82)	-	-	-	
23409, A1759	TAS	*T. truncatus*, B (H82)	-	-	-	***T. australis*^**
23466	TAS	*T. truncatus*, B (H82)	-	-	-	
23463	TAS	*T. truncatus*, B (H89)	*T. truncatus*	*T. truncatus* (Y2)	-	
23465	TAS	*T. truncatus*, B (H89)	*T. truncatus*	-	-	
23412, A2430	TAS	*T. truncatus*, B (H89)	-	-	*T. truncatus*	***T. australis*^**
23418, 1362	TAS	*T. truncatus*, B (H89)	-	-	-	
23176, M18051	SA	*T. truncatus*, B (H89)	-	-	*T. truncatus*	
23312, M5723	SWA	*T. truncatus*, B (H89)	-	-	-	
23539	VIC	*T. truncatus*, B (H90)	*T. truncatus*	*T. truncatus* (Y2)	-	
23541	VIC	*T. truncatus*, B (H90)	*T. truncatus*	*T. truncatus* (Y2)	-	
23542	VIC	*T. truncatus*, B (H90)	*T. truncatus*	*T. truncatus* (Y2)	-	
23545	VIC	*T. truncatus*, B (H90)	*T. truncatus*	-	-	
23546	VIC	*T. truncatus*, B (H90)	*T. truncatus*	*T. truncatus* (Y2)	-	
23548	VIC	*T. truncatus*, B (H90)	*T. truncatus*	-	-	
23404, C29578	VIC	*T. truncatus*, B (H90)	-	-	*T. truncatus*	
C35965	VIC	*T. truncatus*, B (H90)	-	-	*T. truncatus*	***T. australis*^**
C35968	VIC	*T. truncatus*, B (H90)	-	-	*T. truncatus*	***T. australis*^**
C35985	VIC	*T. truncatus*, B (H90)	-	-	*T. truncatus*	***T. australis*^**
C35986	VIC	*T. truncatus*, B (H90)	-	-	*T. truncatus*	***T. australis*^**
C35987	VIC	*T. truncatus*, B (H90)	-	-	*T. truncatus*	***T. australis*^**
C36750	VIC	*T. truncatus*, B (H90)	-	-	*T. truncatus*	***T. australis*^**
23464	TAS	*T. truncatus*, B (H90)	*T. truncatus*	*T. truncatus* (Y2)	-	
23473	TAS	*T. truncatus*, B (H90)	*T. truncatus*	-	-	
23406, A199	TAS	*T. truncatus*, B (H90)	-	-	*T. truncatus*	
23420, 1365	TAS	*T. truncatus*, B (H90)	-	-	*T. truncatus*	***T. australis* type^**
23408, A2443	TAS	*T. truncatus*, B (H90)	-	-		
23427, M10101	SA	*T. truncatus*, B (H90)	-	-	*T. truncatus*	
23533	VIC	*T. truncatus*, B (H101)	*T. truncatus*	-	-	
23254, M20741	SA	*T. truncatus*, B (H101)	-	-	*T. truncatus*	***T. australis*^**
23536	VIC	*T. truncatus*, B (H102)	*T. truncatus*	-	-	

***Supporting Table S4.7*. (continued)**

23540	VIC	*T. truncatus*, B (H102)	*T. truncatus*	-	-	
23550	VIC	*T. truncatus*, B (H102)	*T. truncatus*	*T. truncatus* (Y2)	-	
23395, C29579	VIC	*T. truncatus*, B (H102)	-	-	*T. truncatus*	***T. australis*^**
23398, C24944	VIC	*T. truncatus*, B (H102)	-	-	*T. truncatus*	***T. australis*^**
23400, C29667	VIC	*T. truncatus*, B (H102)	-	-	*T. truncatus*	***T. australis*^**
23403, C29506	VIC	*T. truncatus*, B (H102)	-	-	*T. truncatus*	***T. australis*^**
C10357	VIC	*T. truncatus*, B (H102)	-	-	*T. truncatus*	***T. australis*^**
C29577	VIC	*T. truncatus*, B (H102)	-	-	*T. truncatus*	***T. australis*^**
C29586	VIC	*T. truncatus*, B (H102)	-	-	*T. truncatus*	***T. australis*^**
C35984	VIC	*T. truncatus*, B (H102)	-	-	*T. truncatus*	
C36749	VIC	*T. truncatus*, B (H102)	-	-	-	
23091, M23334	SA	*T. truncatus*, B (H102)	*T. truncatus*	*T. truncatus* (Y2)	*T. truncatus*	
23223, M20736	SA	*T. truncatus*, B (H102)	-	-	*T. truncatus*	
23059, M22430	SA	***T. truncatus*, B (H111)***	*T. aduncus*	-	-	**SABD**
23061, M22528	SA	***T. truncatus*, B (H111)***	*T. aduncus*	-	-	
23075, M22551	SA	***T. truncatus*, B (H111)***	*T. aduncus*	-	-	
23093, M23326	SA	***T. truncatus*, B (H111)***	*T. aduncus*	-	-	
23094, M23327	SA	***T. truncatus*, B (H111)***	*T. aduncus*	-	-	
23209, M19952	SA	***T. truncatus*, B (H111)***	*T. aduncus*	-	*T. aduncus*	
23215, M19979	SA	***T. truncatus*, B (H111)***	*T. aduncus*	-	*T. aduncus*	
23152, M24725	SA	***T. truncatus*, B (H111)***	*T. aduncus*	-	*T. aduncus*	
23095, M23328	SA	***T. truncatus*, B (H112)***	*T. aduncus*	*T. aduncus*, B (Y4)	-	**SABD**
23096, M23329	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	-	
23112, M23663	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	-	
23113, M23666	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	-	
23213, M19991	SA	***T. truncatus*, B (H112)***	*T. aduncus*	*T. aduncus*, B (Y4)	-	
23233, M20874	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	*T. aduncus*	
23170, M16973	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	-	
23175, S0155	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	-	**SABD**
23178, M18052	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	*T. aduncus*	
23183, M18055	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	*T. aduncus*	
23185, M18902	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	*T. aduncus*	
23196, M18095	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	*T. aduncus*	
23198, M18088	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	*T. aduncus*	
23201, M18093	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	*T. aduncus*	
23256, M18048	SA	***T. truncatus*, B (H112)***	*T. aduncus*	*T. aduncus*, B (Y4)	*T. aduncus*	
23085, M23325	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	*T. aduncus*	
23086, M23330	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	-	
23097, M23662	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	-	
23134, M25057	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	-	
23172, M17597	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	-	

***Supporting Table S4.7*. (continued)**

23204, M19954	SA	***T. truncatus*, B (H112)***	*T. aduncus*	-	*T. aduncus*	
23167, M16972	SA	***T. truncatus*, B (H113)***	*T. aduncus*	-	*T. aduncus*	**SABD**
23180, M18053	SA	***T. truncatus*, B (H113)***	*T. aduncus*	*T. aduncus*, B (Y4)	*T. aduncus*	
23214, M19968	SA	***T. truncatus*, B (H113)***	*T. aduncus*	-	*T. aduncus*	
23126, 6.117	SA	***T. truncatus*, B (H113)***	*T. aduncus*	-	-	
23130, M24344	SA	***T. truncatus*, B (H113)***	*T. aduncus*	-	-	
23131, M24456	SA	***T. truncatus*, B (H113)***	*T. aduncus*	*T. aduncus*, B (Y4)	-	
23137, M25055	SA	***T. truncatus*, B (H113)***	*T. aduncus*	-	-	
23161, M16428	SA	***T. truncatus*, B (H113)***	*T. aduncus*	-	*T. aduncus*	
23219, M19969	SA	***T. truncatus*, B (H113)***	*T. aduncus*	-	*T. aduncus*	
23115, M23665	SA	***T. truncatus*, B (H113)***	*T. aduncus*	-		
23226, M21235	SA	***T. truncatus*, B (H113)***	*T. aduncus*	-	*T. aduncus*	
23445, M24456	SA	***T. truncatus*, B (H113)***	-	-	-	
23168, M16426	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	**SABD**
23166, M16427	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23080, M22555	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	-	
23199, M18086	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23207, M19965	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23148, M25496	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23162, M15598	SA	***T. truncatus*, B (H114)***	*T. aduncus*	*T. aduncus*, B (Y4)	*T. aduncus*	
23165, M16392	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23074, M22549	SA	***T. truncatus*, B (H114)***	*T. aduncus*	*T. aduncus*, B (Y4)	*T. aduncus*	
23081, M23323	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23116, M24340	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	-	
23117, M24288	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	-	
23158, M24896	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	**SABD**
23174, M17596	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	-	
23203, M19953	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23212, M19978	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23216, M19973	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23218, M20733	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23221, M20737	SA	***T. truncatus*, B (H114)***	*T. aduncus*	*T. aduncus*, B (Y4)	*T. aduncus*	
23222, M21314	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23227, M20734	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23066, M22532	SA	***T. truncatus*, B (H114)***	*T. aduncus*	-	*T. aduncus*	
23122, M24287	SA	***T. truncatus*, B (H118)***	*T. aduncus*	-	-	**SABD**
23147, M25495	SA	***T. truncatus*, B (H118)***	*T. aduncus*	-	-	
23123, M24289	SA	***T. truncatus*, B (H119)***	*T. aduncus*	-	-	**SABD**

***Supporting Table S4.7*. (continued)**

23132, M24294	SA	***T. truncatus*, B (H120)***	*T. aduncus*	-	*T. aduncus*	**SABD**
23206, M18100	SA	***T. truncatus*, B (H120)***	*T. aduncus*	-	-	
23396, C29462	VIC	*T. truncatus*, B (H139)	-	-	*T. truncatus*	
23402, C25071	VIC	*T. truncatus*, B (H139)	-	-	*T. truncatus*	***T. australis*^**
D. truncatus (353.a)	Red Sea	*T. truncatus*, A (H147)	-	-	*T. truncatus*	Holotype
T. australis (1365)	TAS	*T. truncatus*, B (H90)	-	-	*T. truncatus*	Paralectotyp
T. maugeanus (1360)	TAS	*T. truncatus*, A (H149)	-	-	*T. truncatus*	Junior synonym of *T. truncatus*
D. aduncus (ZMB66400)	UK	*T. truncatus*, C (H148)	-	-	*T. aduncus*	Holotype
D. catalania (1862.6.6.13)	QLD	*T. truncatus*, A (H103)	-	-	*T. aduncus*	Syntype
T. aduncus	Red Sea	*T. truncatus*, C (H150)	-	-	-	

Supporting Table S4.8. Mitochondrial DNA haplotypes and diagnostic sites found for *Tursiops* samples included in the study. Data include state where haplotype was found, haplotype number, number of specimens with that particular haplotype, and group belonging according to the BI tree results. SWA = southern Western Australia, CWA = central Western Australia, NWA = northern Western Australia, NT = Northern Territory, QLD = Queensland, NSW = New South Wales, VIC = Victoria, TAS = Tasmania, SA = South Australia, mtDNA-1 = *T. aduncus* and, mtDNA-2 = *T. truncatus*. The type specimens are in bold, *T. australis* (ID 1365) = H90, *D. catalania* (ID 1862.6.6.13) = H103, *D. truncatus* (ID 353a) = H147, *D. aduncus* (ZMB66400) = H148, and *T. maugeanus* (ID 1360) = H 149.

	7	12	23	26	34	37	39	44	45	62	65	71	77	79	81	83	85	86	87	88	89	90	94	95	96	109	110	112	122	128	129	148	151	161	170	174	175	176	178	185	186	187	188	189	194	196	197	199	212	226	228	229	232
SWA, CWA,QLD H1 (25), mtDNA-2	C	T	C	C	A	G	A	G	T	T	A	T	T	C	T	C	C	A	T	G	T	A	G	C	T	-	C	T	A	T	T	G	-	A	T	T	G	C	C	C	G	A	T	A	C	T	C	T	G	C	C
SWA H2 (29), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	A	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
SWA, CWA H3 (18), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	A	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
SWA H4 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	A	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
SWA H5 (2), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	.	.	.	.	.
SWA H6 (58), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
SWA H7 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	A	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	A	.	.
SWA H8 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	.	.	.	.	.
QLS, NSW H9 (10), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
NT, QLD, NSW H10 (12), mtDNA-1	.	.	T	.	.	.	.	.	.	.	.	C	C	.	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	.	C	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	.	.	.	.	.
QLD, NSW H11 (2), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.	.
QLD, NSW H12 (18), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
QLD, NSW H13 (7), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
QLD NSW H14 (8), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
NWA, TAS H15 (9), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	G	.	.	T	.	.	.	.	.	.	.
NT H16 (2), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	A	.	.
NT H17 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	C	.	T	.	T	.	.	.	.
NT, QLD H18 (17), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NT H19 (3), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NT H20 (9), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	G	T	.	T	.	.	.	.
NT H21 (4), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NT H22 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	.	.	.	.	T	.	.	T	.	T	.	.	.	.
NT H23 (4), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
QLD H24 (12), mtDNA-1	.	.	T	.	.	.	.	.	.	.	.	C	C	.	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	.	C	.	-	.	.	.	.	.	.	.	.	T	.	.	T	.	.	.	.	.	.
NWA, QLD, NSW H25 (30), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA, QLD, NSW H26 (11), mtDNA-1	.	.	T	.	.	.	A	.	.	.	C	C	C	.	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	.	.	.	.	.
QLD H27 (3), mtDNA-1	.	.	T	.	.	.	A	.	C	.	C	C	C	.	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	.	.	.	.	.
QLD H28 (5), mtDNA-1	.	.	T	.	.	.	.	.	.	.	.	C	C	.	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	.	C	.	-	.	.	.	.	.	.	.	.	T	.	.	T	.	.	.	.	.	.
NT, QLD, TAS, VIC, SA H29 (20), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	G	.	.	T	.	.	.	.	.	.	.
NWA, QLD H30 (17), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H31 (1), mtDNA-2	.	C	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	.	.	.	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	T	.	.	.	.	.	.	T	.	.	.	.	.	T
QLD H32 (14), mtDNA-1	.	.	T	.	.	.	.	.	.	.	.	C	C	.	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	.	.	.	.	.
QLD H33 (3), mtDNA-1	.	.	T	.	.	.	.	.	.	.	.	C	C	.	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	.	C	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	.	.	.	.	.
QLD H34 (4), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.
QLD H35 (2), mtDNA-1	.	.	T	.	.	.	.	.	.	.	.	C	C	.	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	.	C	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	.	.	.	.	.
QLD H36 (3), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
QLD H37 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.	.
QLD H38 (1), mtDNA-1	.	.	T	.	.	.	.	.	.	.	.	C	C	.	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	.	C	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	.	.	.	.	.
QLD H39 (4), mtDNA-1	.	.	T	.	.	.	.	.	.	.	.	C	C	.	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	.	C	.	-	.	.	.	.	.	.	.	.	T	.	.	T	.	.	.	.	.	.
QLD H40 (1), mtDNA-1	.	.	T	.	.	.	.	.	.	.	.	C	C	.	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	.	.	.	.	.

***Supporting Table S4.8*. (continued)**

	243	244	245	246	247	250	253	254	255	257	258	259	260	261	262	263	264	265	268	269	271	274	275	276	277	284	286	289	292	297	305	306	308	313	314	316	317	318	319	321	323	325	327	328	329	334	335	338	339
SWA, CWA,QLD H1 (25), mtDNA-2	T	A	T	T	T	C	A	T	C	A	T	T	C	C	A	T	T	A	T	A	T	C	C	G	T	A	G	A	A	G	G	C	T	C	T	C	T	C	A	-	T	A	T	T	T	A
SWA H2 (29), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	C	.	.	-	C	G	.	C	.	.
SWA, CWA H3 (18), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	C	.	.	-	C	G	.	C	.	.
SWA H4 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	C	.	.	C	.	.	-	C	G	.	C	.	.
SWA H5 (2), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	C	.	.	-	.	G	.	C	.	.
SWA H6 (58), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	T	C	.	.	-	C	G	.	C	.	.
SWA H7 (1), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	C	.	.	-	C	G	.	C	.	.
SWA H8 (1), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	C	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	C	.	.	-	.	G	.	C	.	.
QLS, NSW H9 (10), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	T	T	.	.	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	C	.	.	.	.	.	-	.	.	.	C	.	.
NT, QLD, NSW H10 (12), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	C	.	.	.	.	.	A	C	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	-	.	.	.	C	.	.
QLD, NSW H11 (2), mtDNA-2	.	.	C	C	.	.	.	.	.	.	C	C	T	T	.	.	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	C	.	T	.	.	.	.	-	.	.	.	.	C	.
QLD, NSW H12 (18), mtDNA-2	.	.	C	C	.	.	.	.	.	.	.	C	T	T	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	C	.	.	.	.	.	.	-	.	.	.	.	C	.
QLD, NSW H13 (7), mtDNA-2	.	.	C	.	.	.	.	.	.	.	.	C	T	T	.	.	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	C	.	T	.	.	.	.	-	.	.	.	.	C	.
QLD NSW H14 (8), mtDNA-2	.	.	C	C	.	.	.	.	.	.	.	C	T	T	.	.	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	C	.	T	.	.	.	.	-	.	.	.	.	C	.
NWA, TAS H15 (9), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	C	.	T	.	.	.	G	-	.	.	.	C	.	G
NT H16 (2), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	.	.	A	.	T	.	.	.	.	T	C	.	G	-	.	.	.	C	.	.
NT H17 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	.	.	A	.	T	.	.	.	.	T	C	.	G	-	.	.	.	C	.	.
NT, QLD H18 (17), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	.	.	A	.	T	.	.	.	.	T	C	.	G	-	.	.	.	C	.	.
NT H19 (3), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	T	C	.	G	-	.	.	.	C	.	.
NT H20 (9), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	.	.	A	.	G	.	.	.	.	T	C	.	G	-	.	G	.	C	.	.
NT H21 (4), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	.	.	A	.	T	.	.	.	.	.	C	.	G	-	.	G	.	C	.	.
NT H22 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	T	C	.	G	-	.	G	.	C	.	.
NT H23 (4), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	C	.	.	-	.	.	.	C	.	.
QLD H24 (12), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	C	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	-	.	.	.	C	.	.
NWA, QLD, NSW H25 (30), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	C	.	.	-	C	G	.	C	.	.
NWA, QLD, NSW H26 (11), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	C	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	-	.	.	.	C	.	.
QLD H27 (3), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	C	.	.	.	.	.	.	C	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	-	.	.	.	C	.	.
QLD H28 (5), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	C	.	.	.	.	.	A	C	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	-	.	.	.	C	.	.
NT, QLD, TAS, VIC, SA H29 (20), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	T	.	.	.	G	-	.	.	.	C	.	.
NWA, QLD H30 (17), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	G	.	.	T	.	.	.	.	T	C	.	.	-	C	G	.	C	.	G
NWA H31 (1), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	C	.	C	.	.	C	T	.	T	.	.	.	.	.	A	.	T	.	.	.	.	T	.	.	-	.	.	.	C	.	G
QLD H32 (14), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	-	.	.	.	C	.	.
QLD H33 (3), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	C	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	-	.	.	.	C	.	.
QLD H34 (4), mtDNA-2	.	.	C	.	.	.	.	.	.	.	.	.	T	T	.	.	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	C	.	T	.	.	.	.	-	.	.	.	.	C	.
QLD H35 (2), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	-	.	.	.	C	.	.
QLD H36 (3), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	.	.	A	.	T	.	.	.	.	T	C	.	G	-	.	G	.	C	.	G
QLD H37 (1), mtDNA-2	.	.	C	C	.	.	.	.	.	.	.	C	T	T	.	.	.	C	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	C	.	.	.	.	.	.	-	.	.	.	.	C	.
QLD H38 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	.	.	.	.	C	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	-	.	.	.	C	.	.
QLD H39 (4), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	C	.	.	.	.	.	.	C	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	-	.	.	.	.	.	G
QLD H40 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	C	.	.	.	.	.	A	C	.	.	.	.	A	.	T	.	.	.	.	T	.	.	.	-	.	.	.	C	.	G

***Supporting Table S4.8*. (continued)**

	7	1 2	2 3	2 6	3 4	3 7	3 9	4 4	4 5	6 2	6 5	7 1	7 7	7 9	8 1	8 3	8 5	8 6	8 7	8 8	8 9	9 0	9 4	9 5	9 6	1 0 9	1 1 0	1 2 4	1 2 8	1 2 9	1 4 8	1 5 1	1 6	1 7 4	1 7 5	1 8 0	1 8 4	1 8 5	1 8 6	1 8 7	1 8 8	1 9 4	1 9 6	1 9 7	1 9 9	2 1 5	2 2 6	2 2 8	2 2 9	2 3 0	2 3 2
	C	T	C	C	A	G	A	G	T	T	A	T	T	C	T	C	C	A	T	G	T	A	G	C	T	-	C	T	A	T	T	G	-	A	T	T	G	C	C	C	G	A	T	A	C	T	C	T	G	C	C
QLD H41 (1), mtDNA-1	.	.	T	T	.	.	.	.	.	.	.	C	C	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	T	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	.	.	.	.	.
CWA H42 (12), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CWA H43 (24), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	.	.	T	.	.	.	.
NWA H44 (6), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
CWA H45 (2), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H46 (2), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	G	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA, QLD H47 (4), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H48 (7), mtDNA-1	.	.	.	.	G	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H49 (2), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	C	.	.	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H50 (10), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H51 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H52 (6), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	T	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H53 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	.	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H54 (2), mtDNA-1	.	.	.	.	G	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H55 (5), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	G	T	.	T	.	.	.	.
NWA H56 (4), mtDNA-1	.	.	T	.	G	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA, NT H57 (9), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H58 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H59 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H60 (2), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA H61 (2), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	A	.	.
NWA, SA H62 (3), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	T	.	.	.	.	.	.	T	.	.	.	.	.	T
NWA H63 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	.	.	.	.	T	.	.	.	.	T	.	.	.	.
NWA H64 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.
NWA, TAS H65 (4), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.
NWA H66 (2), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.
NWA, TAS H67 (11), mtDNA-2	.	.	T	.	.	A	.	.	.	.	G	.	.	.	.	T	.	.	.	.	.	.	.	.	.	T	.	.	.	C	.	.	-	.	.	.	.	.	T	.	.	.	.	.	.	.	.	.	A	.	T
NWA, QLD, TAS, VIC H68 (33), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.
NWA H69 (4), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	G	.	.	T	.	.	.	.
NWA H70 (13), mtDNA-2	.	C	.	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	T	.	.	.	.	G	.	.	T	.	.	.	.
NWA H71 (14), mtDNA-2	.	C	.	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	G	.	.	T	.	.	.	.
NWA H72 (4), mtDNA-2	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	.	.	G	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.
NWA H73 (2), mtDNA-2	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	.	.	G	.	.	.	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.
NWA, TAS H74 (3), mtDNA-2	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	.	.	G	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.
NWA H75 (2), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.
NWA H76 (1), mtDNA-2	.	C	.	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	C	.	-	.	.	.	.	.	.	.	.	.	.	G	.	.	T	.	.	.	.
NWA, NT H77 (4), mtDNA-2	T	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	.	.	G	.	.	.	-	.	.	.	C	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
NWA H78 (1), mtDNA-2	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	.	.	G	.	.	.	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.
NWA H79 (1), mtDNA-2	.	C	.	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	G	.	.	T	.	.	.	.
NWA H80 (2), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.
NWA H81 (1), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	T	.	.	.	.	G	.	.	.	.	.	.	.
TAS, VIC H82 (11), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	T	C	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	A	.
TAS H83 (2), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.
TAS H84 (4), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	A	.	.	-	.	.	.	.	.	A	-	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.

***Supporting Table S4.8*. (continued)**

	243	244	245	246	247	250	253	254	255	257	258	239	260	261	262	263	264	265	268	269	271	274	275	276	284	286	289	293	297	305	306	328	338	347	348	351	354	372	373	374	375	389	390	391	393	435	438	439	469
	T	A	T	T	T	C	A	T	C	A	T	T	C	C	A	T	T	T	A	T	A	T	C	C	G	T	A	G	A	A	G	G	C	T	C	T	T	C	C	T	C	A	-	T	A	T	T	T	A
QLD H41 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	.	-	.	.	.	C	.	G
CWA H42 (12), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-	.	.	.	.	.	.
CWA H43 (24), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	.	C	.	.	-	C	G	.	C	.	.
NWA H44 (6), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	.	C	.	.	-	C	G	.	C	.	.
CWA H45 (2), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	T	.	.	.	.	G	.	.	T	.	.	.	.	.	T	C	.	.	-	C	G	.	C	.	.
NWA H46 (2), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	T	.	C	.	.	-	.	G	.	C	.	G
NWA, QLD H47 (4), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	.	C	.	.	-	.	G	.	C	.	G
NWA H48 (7), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	T	C	.	.	-	C	G	.	C	.	G
NWA H49 (2), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	.	C	.	.	-	.	G	.	C	.	G
NWA H50 (10), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	G	.	.	T	.	.	.	.	.	T	C	.	.	-	C	G	.	C	.	G
NWA H51 (1), mtDNA-1	.	G	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	T	C	.	.	-	C	G	.	C	.	G
NWA H52 (6), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	G	.	.	T	.	.	.	.	.	T	C	.	.	-	C	G	.	C	.	G
NWA H53 (1), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	.	C	.	.	-	C	G	.	C	.	G
NWA H54 (2), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	T	C	.	.	-	C	G	.	C	.	G
NWA H55 (5), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	T	C	.	.	-	C	G	.	C	.	G
NWA H56 (4), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	T	C	.	.	-	C	G	.	C	.	G
NWA, NT H57 (9), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	T	C	.	G	-	.	G	.	C	.	G
NWA H58 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	.	C	.	.	-	.	G	.	C	.	G
NWA H59 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	C	.	.	.	.	.	.	A	C	.	.	.	.	A	.	T	.	.	.	.	.	T	C	.	G	-	.	G	.	C	.	G
NWA H60 (2), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	G	.	.	.	T	.	.	.	.	.	.	C	.	.	-	C	G	.	C	.	G
NWA H61 (2), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	T	C	.	.	-	C	G	.	C	.	G
NWA, SA H62 (3), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	-	.	.	.	C	.	G
NWA H63 (1), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	T	C	.	.	-	C	G	.	C	.	G
NWA H64 (1), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	G	C	.	.	.	.	.	.	.	A	.	.	.	.	G	.	.	T	.	.	.	.	.	T	C	.	.	-	C	G	.	C	.	G
NWA, TAS H65 (4), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	C	.	T	.	.	.	G	-	.	.	.	C	.	.
NWA H66 (2), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	.	.	.	.	-	.	.	.	C	.	.
NWA, TAS H67 (11), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	.	.	.	G	.	.	.	.	C	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	A	.	.	.	C	.	.
NWA, QLD, TAS, VIC H68 (33), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	G	-	.	.	.	C	.	.
NWA H69 (4), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	G	.	A	.	.	.	.	.	.	T	.	.	.	G	-	.	.	.	C	.	.
NWA H70 (13), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	G	-	.	.	.	C	.	.
NWA H71 (14), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	G	-	.	.	.	C	.	.
NWA H72 (4), mtDNA-2	.	.	.	C	.	.	G	.	.	.	.	.	.	T	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	-	.	.	.	C	.	.
NWA H73 (2), mtDNA-2	.	.	.	C	.	.	G	.	.	.	.	.	.	T	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	-	.	.	.	C	.	.
NWA, TAS H74 (3), mtDNA-2	.	.	.	C	.	.	G	.	.	.	.	.	.	T	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	-	.	.	.	C	.	.
NWA H75 (2), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	T	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	C	.	T	.	.	.	G	-	.	.	.	C	.	.
NWA H76 (1), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	G	-	.	.	.	C	.	G
NWA, NT H77 (4), mtDNA-2	C	.	.	G	.	.	.	.	.	.	.	C	.	T	.	.	.	.	.	.	.	C	.	.	A	.	.	.	.	.	A	.	.	.	.	C	.	.	.	.	.	.	-	.	.	.	C	.	G
NWA H78 (1), mtDNA-2	.	.	.	C	.	.	G	.	.	.	.	.	.	T	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	-	.	.	.	C	.	G
NWA H79 (1), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	.	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	G	-	.	.	.	C	.	G
NWA H80 (2), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	G	-	.	.	.	C	.	G
NWA H81 (1), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	.	.	.	G	-	.	.	.	C	.	G
TAS, VIC H82 (11), mtDNA-2	.	.	.	A	.	.	.	.	.	.	A	.	T	T	.	.	A	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	A	.	.	.	C	.	.
TAS H83 (2), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	C	.	T	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	G	-	.	.	.	C	.	.
TAS H84 (4), mtDNA-2	.	.	.	C	.	T	.	.	.	.	.	C	T	T	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	G	-	.	.	.	C	.	.

***Supporting Table S4.8*. (continued)**

	7	12	23	26	34	37	39	44	45	62	65	71	77	79	81	83	85	86	87	88	89	90	94	95	96	109	110	112	128	129	148	151	166	177	184	185	186	187	188	189	194	196	197	199	215	226	228	229	230	232
TAS H85 (2), mtDNA-2	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TAS, VIC, SA H86 (10), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	-	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.
TAS H87 (3), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	-	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.
TAS, VIC, SA H88 (4), mtDNA-2	.	C	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	T	.	.	.	.	.
TAS, SA, WA H89 (6), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	T	C	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.	A	.
TAS, VIC, SA *T. australis* H90 (19), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.	A	.
TAS H91 (1), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	-	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TAS H92 (2), mtDNA-2	.	.	.	.	.	.	.	A	.	.	.	.	C	.	.	.	.	G	.	.	.	G	.	.	C	-	.	.	.	C	.	.	.	.	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.
TAS H93 (2), mtDNA-2	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TAS, VIC H94 (2), mtDNA-2	.	C	T	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	T	.	.	.	.	.
TAS H95 (2), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	T	.	T	.	.	.	C	G	A	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.
TAS H96 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	A	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.
TAS H97 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	G	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.
TAS H98 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	G	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	T	.	.	.	.	.
TAS H99 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	T	.	T	.	.	.
TAS H100 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T
VIC, SA H101 (2), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.	A	.
VIC, SA H102 (14), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	.	.	.	.	.	.	T	.	C	.	.	.	.	.	.	A	.
NT, *D. Catalania* H103 (2), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	.	.	.	.	T	.	.	.	T	.	T	.	T	.	.	.	.	.
NT H104 (2), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	.	.	.	.	T	.	.	.	T	.	G	T	.	T	.	.	.	.
NSW H105 (1), mtDNA-1	.	C	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.
NWA H106 (2), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	C	.	-	.	.	.	T	.	.	.	T	.	T	.	T	.	.	.	.	.
NWA, NT H107 (4), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	T	.	.	.	T	.	T	.	T	.	.	.	.	.
NWA H108 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	T	.	.	.	T	.	T	.	T	.	.	.	.	.
NWA NT H109 (3), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	T	.	.	.	T	.	T	.	T	.	.	.	.	.
NT H110 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	C	.	-	.	.	.	T	.	.	.	T	.	T	.	T	C	.	.	.
SA H111 (8), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	A	.
SA H112 (21), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	T	.	A	A	.
SA H113 (12), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	T	.	.	A	.
SA H114 (22), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	T	.	.	A	.
SA H115 (7), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	T	.	.	A	.
SA H116 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	.	-	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.
SA H117 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	.	-	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.
SA H118 (2), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	.	.	.	A	.
SA H119 (1), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	T	.	.	A	.
SA H120 (2), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	T	.	A	G	.
NSW H121 (1), mtDNA-1	.	.	T	.	.	.	.	A	.	.	.	C	C	.	.	.	.	.	.	.	.	.	A	.	.	-	.	.	.	.	C	.	-	.	.	.	T	.	.	.	T	.	.	.	.	.	.	.	.	.
NSW H122 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.
NSW H123 (1), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	T	.	.	.	.	.
NSW H124 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.
NSW H125 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
NSW H126 (2), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	.	-	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
NT H127 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	T	.	.	.	T	.	T	.	T	.	.	.	.	.
NT H128 (3), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	G	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	T	.	.	.	T	.	T	.	T	.	.	.	.	.

***Supporting Table S4.8*. (continued)**

	243	244	245	246	247	250	253	254	255	257	258	239	260	261	262	263	264	265	268	269	271	274	275	276	284	286	289	293	297	305	306	328	338	347	348	351	354	372	373	374	375	389	390	391	393	435	438	439	469
TAS H85 (2), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	T	T	.	.	.	.	.	.	.	C	.	.	A	.	.	.	.	.	A	.	.	.	.	C	.	T	.	.	.	.	-	.	.	.	C	.	.
TAS, VIC, SA H86 (10), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	.	T	T	.	.	C	.	.	.	.	.	T	.	A	.	.	.	.	.	A	.	.	.	.	C	.	T	.	.	.	.	-	.	.	.	C	.	.
TAS H87 (3), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	.	T	T	.	C	C	.	.	.	.	.	T	.	A	.	.	.	.	.	A	.	.	.	.	C	.	T	.	.	.	.	-	.	.	.	C	.	.
TAS, VIC, SA H88 (4), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	-	.	.	.	C	.	.
TAS, SA, WA H89 (6), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	A	.	.	.	C	.	.
TAS, VIC, SA *T. australis* H90 (19), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	A	.	.	.	C	.	.
TAS H91 (1), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	C	.	T	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	A	A	T	.	.	C	.	.	.	.	.	.	-	.	.	.	C	.	.
TAS H92 (2), mtDNA-2	.	.	.	G	.	.	.	.	.	.	.	.	.	T	.	.	C	.	.	.	.	.	T	.	.	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	-	.	.	.	C	.	.
TAS H93 (2), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	T	T	.	.	.	.	.	.	.	C	.	.	A	.	.	.	.	.	A	.	.	.	.	C	.	T	.	.	.	.	-	.	.	.	C	.	.
TAS, VIC H94 (2), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	G	-	.	.	.	C	.	.
TAS H95 (2), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	G	-	.	.	C	C	.	.
TAS H96 (1), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	T	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	G	-	.	.	.	C	.	.
TAS H97 (1), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	.	C	.	.	.	.	C	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	G	-	.	.	.	.	.	.
TAS H98 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	C	T	T	.	C	C	.	.	.	.	.	T	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	G	-	.	.	.	C	.	.
TAS H99 (1), mtDNA-2	.	.	.	C	C	.	.	.	A	.	.	.	.	T	.	.	C	.	.	.	.	C	.	.	.	.	.	.	.	.	A	.	.	.	.	C	.	T	.	.	T	.	-	.	.	.	.	C	.
TAS H100 (1), mtDNA-2	.	.	.	A	.	.	.	C	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	.	.	T	.	-	.	.	.	C	.	.
VIC, SA H101 (2), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	T	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	A	.	.	.	C	.	.
VIC, SA H102 (14), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	A	.	.	.	C	.	.
NT, *D. Catalania* H103 (2), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	.	C	.	.	-	.	G	.	C	C	G
NT H104 (2), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	.	.	.	A	.	A	.	.	.	.	.	T	C	.	G	-	.	G	.	C	.	G
NSW H105 (1), mtDNA-1	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	G	-	.	.	.	C	.	G
NWA H106 (2), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	.	.	.	A	.	T	.	.	.	.	.	.	C	.	G	-	.	G	.	C	.	G
NWA, NT H107 (4), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	T	C	.	G	-	.	G	.	C	.	G
NWA H108 (1), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	C	.	.	.	C	.	.	-	.	G	.	C	.	G
NWA NT H109 (3), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	.	C	.	.	A	.	.	.	C	.	G
NT H110 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	.	.	.	A	.	T	.	.	.	.	.	.	C	.	G	-	.	G	.	C	.	G
SA H111 (8), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	A	.	.	.	C	.	.
SA H112 (21), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	C	.	T	.	.	.	.	A	.	.	.	C	.	.
SA H113 (12), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	A	A	.	.	.	.	.	T	.	.	.	.	A	.	.	.	C	.	G
SA H114 (22), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	A	.	.	.	C	.	G
SA H115 (7), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	C	.	G
SA H116 (1), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	.	T	T	.	.	.	.	.	.	.	.	T	.	A	.	.	.	.	.	A	.	.	.	.	C	.	T	.	.	.	.	-	.	.	.	C	.	G
SA H117 (1), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	.	T	T	.	.	C	.	.	.	.	.	T	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	A	.	.	.	C	.	G
SA H118 (2), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	A	A	.	.	.	.	.	T	.	.	.	.	A	.	.	.	C	.	.
SA H119 (1), mtDNA-2	.	.	.	A	.	.	.	.	.	G	.	.	T	T	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	A	.	.	.	C	.	G
SA H120 (2), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	C	.	T	.	.	.	.	A	.	.	.	C	.	G
NSW H121 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	C	.	.	.	.	.	.	.	C	.	.	.	.	A	.	T	-	C	.	G	.	.	.	.	.	.	.	.	.	.	.	.
NSW H122 (1), mtDNA-2	.	.	C	C	.	.	.	.	.	.	.	C	T	T	.	.	C	.	.	.	.	.	.	.	A	.	G	.	.	.	A	.	.	C	.	.	.	.	.	.	-	.	.	.	.	C	G	.	.
NSW H123 (1), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	.	G	-	.	.	.	C	.	G	.	.
NSW H124 (1), mtDNA-2	.	.	C	C	.	.	.	.	.	.	.	C	T	T	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	C	C	T	.	.	.	.	-	.	.	.	.	C	G	.	.
NSW H125 (1), mtDNA-2	.	.	C	.	.	.	.	.	.	.	.	.	T	T	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	C	.	.	.	.	.	.	-	.	.	.	C	.	G	.	.
NSW H126 (2), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	.	T	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	C	.	T	.	.	.	.	-	.	.	.	C	.	G	.	.
NT H127 (1), mtDNA-1	.	.	.	G	.		-	.	T	.	.	.	T	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	C	.	g	-	G	.	C	.	G	.	.	.	.
NT H128 (3), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	.	.	.	A	.	T	.	.	.	T	C	.	G	-	.	G	.	C	.	G	.	.

***Supporting Table S4.8*. (continued)**

	7	12	23	26	34	37	39	44	45	62	65	71	77	79	81	83	85	86	87	88	89	90	94	95	96	109	110	112	122	128	129	144	148	155	164	167	178	180	184	185	186	188	188	189	194	196	197	199	199	212	226	228	229	230	232
NT H129 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	T	.	.	.	.	.	.	.	.	.	.	.
QLD H130 (1), mtDNA-1	.	.	T	.	.	.	.	.	.	.	.	C	C	.	.	.	.	.	.	.	.	A	.	.	.	-	.	.	.	.	C	.	-	.	.	.	.	.	.	.	.	T	.	.	T	.	.	.	.	.	.	.	.	.	.
QLD, SA H131 (5), mtDNA-2	.	.	T	.	.	A	G	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	T	.	-	.	.	.	.	C	.	.	-	.	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.
QLD, TAS H132 (2), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	.	.	.
QLD H133 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SA H134 (1), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.	A	.	G	.	.	.	-	.	C	.	.	.	.	-	.	.	.	A	.	T	.	.	.	.	.	.	T	.	.	A	.	.	.	.	.	.
SA H135 (1), mtDNA-2	.	C	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	G	.	.	T	.	.	.	.	.	.	.	.
TAS H136 (1), mtDNA-2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	.	.	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	.	.	.
TAS H137 (1), mtDNA-2	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	T	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	.	.	.
TAS H138 (1), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	-	.	.	.	.	.	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	.
VIC H139 (2), mtDNA-2	.	.	T	.	.	.	.	.	.	.	.	.	C	.	.	.	.	G	.	A	.	G	.	.	.	-	.	C	.	.	.	.	-	.	.	.	.	.	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	.
SWA H140 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	A	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	T	.	T	.	.	.	.	.	.	.	.	.
NT H141 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	T	.	T	.	.	.	.	.	.	.	.	.
NT H142 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	T	.	T	.	.	.	.	.	.	.	.	.
NT H143 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	T	.	.	.	.	.	.	.	.	.	.	.
NT H144 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	T	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	T	A	T	.	.	T	.	T	.	.	.	.	.	.	.	.
NT H145 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	.	.	.	.	T	.	.	T	.	T	.	.	.	.	.	.	.	.
NT H146 (1), mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	T	.	.	.	.	.	.	.	.	-	.	.	G	.	.	.	-	.	.	.	.	T	.	.	.	T	.	.	T	.	T	.	.	.	.	.	.	.	.
***D. truncatus* H147, mtDNA-2**	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	C	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	.	.	.
***D. aduncus* H148, mtDNA-1**	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	T	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.
***T. maugeanus* H149, mtDNA-2**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	C	G	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	G	.	.	T	.	.	.	.	.	.	.	.	.
Red Sea, mtDNA-1	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.	-	.	.	.	.	.	.	-	.	.	.	.	T	.	.	.	.	.	T	.	.	.	A	.	.	.	.	.	.	.

***Supporting Table S4.8*. (continued)**

	243	244	245	246	2.47	250	253	254	255	257	258	259	260	261	262	263	264	265	266	268	269	271	274	275	276	284	286	289	293	297	305	320	338	347	348	351	355	377	378	379	384	399	401	413	435	438	439	469
NT H129 (1), mtDNA-1	.	.	.	G	.	.		.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	A	T	.	.	t	C	.	G	-	.	G	.	C	.	G	.	.	.	.	.	.	.
QLD H130 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	C	.	.	.	.	.	.	.	A	C	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	C	.	G	.	.
QLD, SA H131 (5), mtDNA-2	.	.	.	A	.	A	.	.	.	.	.	.	T	T	.	C	A	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	.	.	.	.	.	A	.	.	.	C	.	G
QLD, TAS H132 (2), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	.	.	.	.	.	.	C	.	.	A	.	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	G	-	.	.	.	.	.	G
QLD H133 (1), mtDNA-2	.	.	C	C	.	.	.	.	.	.	.	C	T	T	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	C	.	.	.	.	.	.	-	.	.	.	.	C	G
SA H134 (1), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	.	.	.	A	.	.	.	C	.	G
SA H135 (1), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	G	-	.	.	.	C	.	G
TAS H136 (1), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	G	A	-	.	.	C	.	G	.
TAS H137 (1), mtDNA-2	.	.	.	C	.	.	.	.	.	.	.	C	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	.	.	.	.	G	-	.	.	.	C	.	G
TAS H138 (1), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	A	.	.	.	A	A	T	T	.	A	.	.	C	.	G	.	.	.	.	-	.	.	.	.	.	.
VIC H139 (2), mtDNA-2	.	.	.	A	.	.	.	.	.	.	.	.	T	T	.	.	A	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	A	.	.	C	.	G	.
SWA H140 (1), mtDNA-1	.	.	.	G	.	T	-	.	.	.	.	.	T	.	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	.	C	.	.	-	C	G	C	.	G	.
NT H141 (1), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	T	.	C	.	.	-	.	.	C	.	.	.
NT H142 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	.	.	.	A	.	.	A	.	.	.	.	.	.	.	T	C	.	G	-	.	.	C	.	.	.
NT H143 (1), mtDNA-1	.	.	.	G	.	T	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	.	C	.	.	-	.	.	C	.	.	.
NT H144 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	.	C	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	T	.	.	.	.	.	.	C	.	.	-	.	G	.	C	.	.
NT H145 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	.	.	.	G	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	.	C	.	G	-	.	G	.	C	.	.
NT H146 (1), mtDNA-1	.	.	.	G	.	.	-	.	T	.	.	.	T	.	.	C	C	C	.	C	.	.	.	.	A	.	.	.	.	.	A	.	T	.	.	.	.	.	T	C	.	.	-	.	G	.	C	.	.
***D. truncatus* H147, mtDNA-2**	.	.	.	C	.	.	.	.	.	.	.	.	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	-	.	.	.	.	.	.
***D. aduncus* H148, mtDNA-1**	.	.	.	A	.	.	-	.	.	.	.	.	T	.	.	.	C	.	.	.	G	.	.	.	.	.	.	.	.	.	A	.	.	.	.	C	.	T	.	.	.	.	-	.	.	.	.	.	.
***T. maugeanus* H149, mtDNA-2**	.	.	.	C	.	.	.	.	.	.	.	.	.	T	.	C	C	.	.	.	.	.	.	.	A	.	.	.	.	.	A	.	.	.	.	.	.	T	.	.	.	.	-	.	.	.	.	.	.
Red Sea, mtDNA-1	.	.	.	A	.	.	-	.	.	.	.	.	T	.	.	.	C	.	.	.	G	.	.	.	A	.	.	.	.	.	A	.	.	.	.	C	.	T	.	.	.	.	-	.	.	.	.	.	.

Supporting Table S4.9. Pairwise fixation index Φ_{ST} for mitochondrial data for *T. aduncus* as identified by STRUCTURE. Significance level of $P > 0.05$ is indicated by *, and ** of significance level of $P > 0.001$, numbers in bold show non-significant values. Twenty three geographical sampling locations were identified; Town = Townsville (QLD), Kepp = Keppel Bay (QLD), Bunk = Bunker group reef (QLD), MB = Morton Bay (QLD), NSW = northern New South Wales (NSW), G SV = Gulf St Vincent (SA), SG = Spencer Gulf (SA), PL = Port Lincoln (SA), Coff = Coffin Bay (SA), W SA = western South Australia (SA), Aug = Augusta (southern WA), Bun = Bunbury (southern WA), Perth (southern WA), E SB = eastern Shark Bay (central WA), W SB = western Shark Bay (central WA), CB = Coral Bay (northern WA), Ex = Exmouth (northern WA), Ons = Onslow (northern WA), Dam = Dampier (northern WA), PH = Port Hedland (northern WA), Bro = Broome (northern WA), Cob = Cobourg (NT), and Darw = Darwin (NT).

Φ_{ST} mt	**Town**	**Kepp**	**Bunk**	**MB**	**NSW**	**G SV**	**SG**	**PL**	**Coff**	**W SA**	**Aug**	**Bun**	**Perth**	**E SB**	**W SB**	**CB**	**Ex**	**Ons**	**Dam**	**PH**	**Bro**	**Cob**	**Darw**
Town (QLD)																							
Kepp (QLD)	**0.227**																						
Bunk (QLD)	**0.163**	0.130*																					
MB (QLD)	**0.039**	0.178*	0.185**																				
N NSW (NSW)	**0.369**	0.447*	0.304*	**0.096**																			
G SV (SA)	0.934*	0.862**	0.881**	0.794**	0.978**																		
SG (SA)	0.924**	0.854**	0.875**	0.797**	0.967**	0.223*																	
PL (SA)	0.902**	0.839**	0.865**	0.790**	0.944**	0.506*	0.510**																
Coff (SA)	0.884**	0.831**	0.858**	0.772**	0.929*	0.469**	0.549**	**0.183**															
W SA (SA)	0.805**	0.758**	0.809**	0.731**	0.860*	0.545**	0.564**	0.138*	**0.129**														
Aug (S WA)	0.911*	0.803**	0.836**	0.716**	1.000**	0.971**	0.957**	0.932**	0.912**	0.834*													
Bun (S WA)	0.609**	0.574**	0.666**	0.513**	0.664**	0.813**	0.816**	0.808**	0.793**	0.758**	0.693*												
Perth (S WA)	0.484*	0.466**	0.575**	0.430**	0.551*	0.733**	0.738**	0.730**	0.709**	0.655**	0.515*	**0.022**											
E SB (C WA)	0.444*	0.435**	0.540**	0.410**	0.523**	0.690**	0.696**	0.692**	0.667**	0.607**	0.391**	0.153*	**0.009**										
W SB (C WA)	0.668**	0.623**	0.711**	0.538**	0.717**	0.843**	0.845**	0.838**	0.825**	0.795**	0.772**	0.216**	0.151*	0.228**									
CB (N WA)	0.816*	0.681**	0.780**	0.621**	0.874*	0.935**	0.929**	0.915**	0.908**	0.862**	0.910*	0.344**	0.288*	0.371*	0.292**								
Ex (N WA)	0.808**	0.714**	0.792**	0.667**	0.840**	0.913**	0.911**	0.904**	0.900**	0.878**	0.886**	0.411**	0.388**	0.474**	0.334**	**0.024**							
Ons (N WA)	0.892**	0.731**	0.816**	0.637**	0.975**	0.975*	0.966**	0.947**	0.939**	0.888*	0.983*	0.369*	0.283*	0.368*	0.274*	**0.087**	**0.023**						
Dam (N WA)	0.891**	0.796**	0.850**	0.712**	0.925**	0.956**	0.952**	0.944**	0.940**	0.919**	0.945**	0.453**	0.415**	0.497**	0.379**	**0.080**	**0.007**	**0.056**					
PH (N WA)	0.925**	0.837**	0.878**	0.743**	0.955**	0.970**	0.967**	0.959**	0.956**	0.939**	0.966**	0.496**	0.453**	0.532**	0.409**	0.144*	0.054*	**0.017**	**0.024**				
Bro (N WA)	0.740**	0.614**	0.730**	0.595**	0.784**	0.887**	0.884**	0.875**	0.871**	0.837**	0.846**	0.320**	0.301**	0.385**	0.286**	**0.005**	0.078*	0.132*	0.159**	0.230**			
Cob (NT)	0.781*	0.608**	0.751**	0.547**	0.899*	0.947**	0.939**	0.920**	0.905**	0.844*	0.935*	0.529**	0.415*	0.410*	0.547**	0.733**	0.699**	0.849*	0.829**	0.882**	0.599**		
Darw (NT)	0.722**	0.563**	0.721**	0.562**	0.803**	0.901**	0.896**	0.885**	0.875**	0.824**	0.860**	0.485**	0.401**	0.410**	0.500**	0.592**	0.595**	0.673**	0.721**	0.780**	0.462**	0.239*	

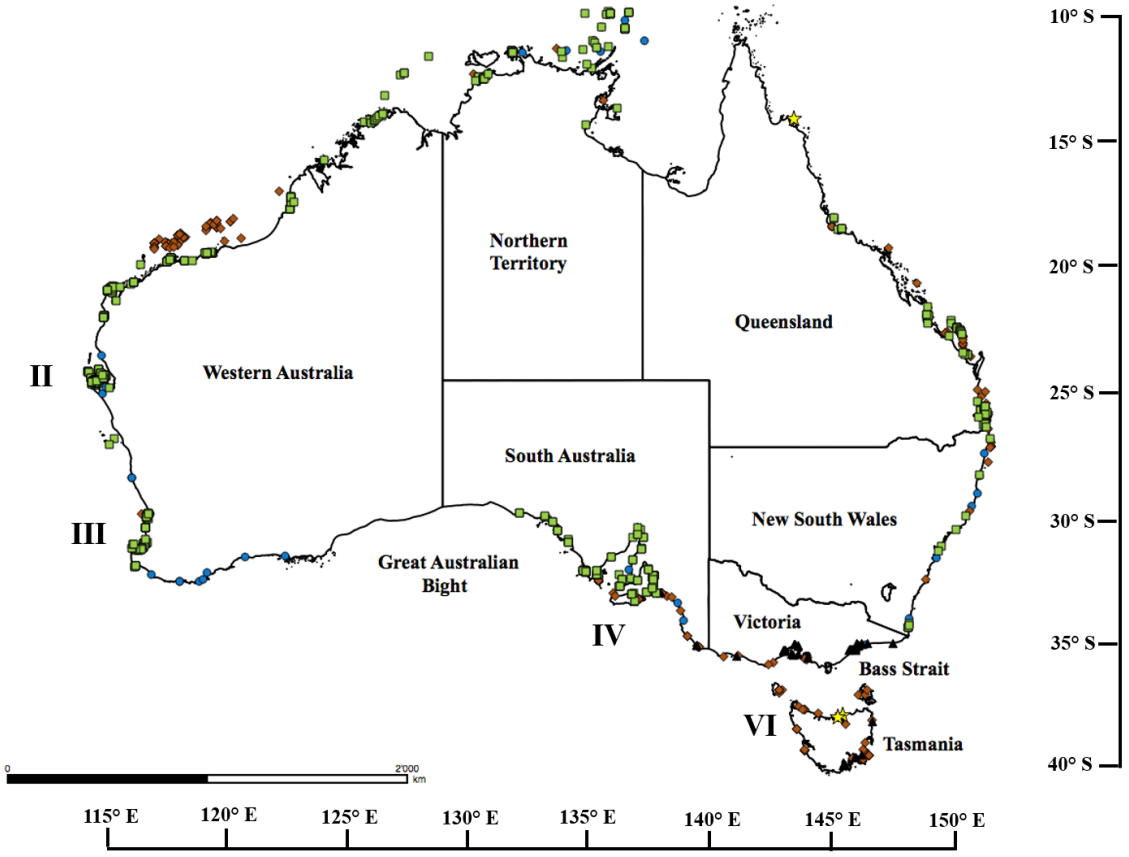
Supporting Table S4.10. Pairwise fixation index Φ_{ST} for mitochondrial data for *T. truncatus* as identified by STRUCTURE. Significance level of $P > 0.05$ is indicated by *, and ** of significance level of $P > 0.001$, numbers in bold show non-significant values. Twelve geographical sampling locations were identified; Bunk = Bunker group reef (QLD), MB = Moreton Bay (QLD), N NSW = northern NSW (NSW), E VIC = eastern VIC, PPB = Port Phillip Bay (VIC), E TAS = eastern TAS, W TAS = western TAS, N TAS = northern TAS, King = King Island (TAS), KI = Kangaroo Island (SA), W Pil = western Pilbara (WA), and E Pil = eastern Pilbara (WA).

Φ_{ST} mt	**Bunk**	**MB**	**N NSW**	**E VIC**	**PPB**	**E TAS**	**W TAS**	**N TAS**	**King**	**KI**	**W Pil**	**E Pil**
Bunk (QLD)												
MB (QLD)	**0.041**											
N NSW	**-0.035**	**-0.042**										
E VIC	0.825**	0.718**	0.830**									
PPB (VIC)	0.789**	0.622**	0.776**	0.421**								
E TAS	0.455**	0.256**	0.336**	0.342**	0.228*							
W TAS	0.405**	0.203**	0.280**	0.579**	0.474**	0.073*						
N TAS	0.511**	0.326**	0.420**	0.660**	0.608**	0.126*	0.060*					
King (TAS)	0.560**	0.32**	0.462**	0.765**	0.683**	0.145*	**-0.027**	0.088*				
KI (SA)	0.456**	0.31**	0.367**	0.395**	0.295*	**0.025**	0.168**	0.197**	0.233**			
W Pil (N WA)	0.568**	0.413**	0.502**	0.689**	0.645**	0.208**	0.161**	0.093*	0.160**	0.309**		
E Pil (N WA)	0.553**	0.37**	0.462**	0.649**	0.566**	0.133*	0.126**	0.146**	0.166*	0.170*	0.073*	

*Supporting Table S4.11.*Y-chromosome haplotypes and diagnostic sites found for *Tursiops* samples included in the study. Data include state where haplotype was found, haplotype number, number of specimens with that particular haplotype, and group belonging according to the BI tree results. QLD = Queensland, NSW = New South Wales, VIC = Victoria, TAS = Tasmania, SA = South Australia, SWA = southern Western Australia, CWA = central Western Australia, NWA = northern Western Australia, and NT = Northern Territory.

	1	1	6	8	9	1 0	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
	1	9	0	4	2	9	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	6	7	7	7
	7	0	0	5	1	2	3	4	5	6	7	8	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2
QLD, NSW, SWA, CWA, NWA, NT, Y-1 (30), Y-1	G	A	A	A	T	T	T	G	A	T	G	C	C	T	C	T	A	T	T	G	G	C	T	A	T	T	G
QLD, NSW, VIC, TAS, NWA Y2 (42), Y-2	A	G	T	A	C	T	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QLD Y3 (1), Y-1	G	A	A	A	T	G	T	G	A	T	G	C	C	T	C	T	A	T	T	G	G	C	T	A	T	T	G
SA, SWA Y4 (14), Y-1	G	G	A	A	T	T	T	G	A	T	G	C	C	T	C	T	A	T	T	G	G	C	T	A	T	T	G
CWA Y5 (1), Y-1	G	A	A	G	T	T	T	G	A	T	G	C	C	T	C	T	A	T	T	G	G	C	T	A	T	T	G

Supporting Fig. S4.12. Location and species identification (based on Allen et al. 2016 and Kemper 2004) of the soft tissue and bone/teeth samples of *Tursiops* spp. used in the study. Green squares = *T. aduncus*, brown diamonds = *T. truncatus*, black triangle = *T. australis*, yellow stars = type specimens, and blue circles = unknown species identification.



Curriculum Vitae

Personal Information

Name:	Maria Jedensjö
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Education

2010-2019	**PhD, University of Zürich, Switzerland** Title: Combining genetics and morphology to resolve a longstanding taxonomic issue: how many bottlenose dolphin species are there in Australian waters?
2004-2006	**MSc, Lund University, Sweden** Title: The effect of violated guidelines on the behaviour of Indo-Pacific bottlenose dolphins off the South coast of Zanzibar.
2001-2004	**BSc, Lund University, Sweden** Final year project title: Feeding habits of Australian snubfin (*Orcaella heinsohni*) and Indo-Pacific humpback dolphins (*Sousa chinensis*)

Selected Publications

Parra, G.J. and Jedensjö, M. 2014. Stomach contents of Australian snubfin (*Orcaella heinsohni*) and Indo-Pacific humpback dolphins (*Sousa chinensis*). Marine Mammal Science, 30(3): 1184−1198.

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